This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

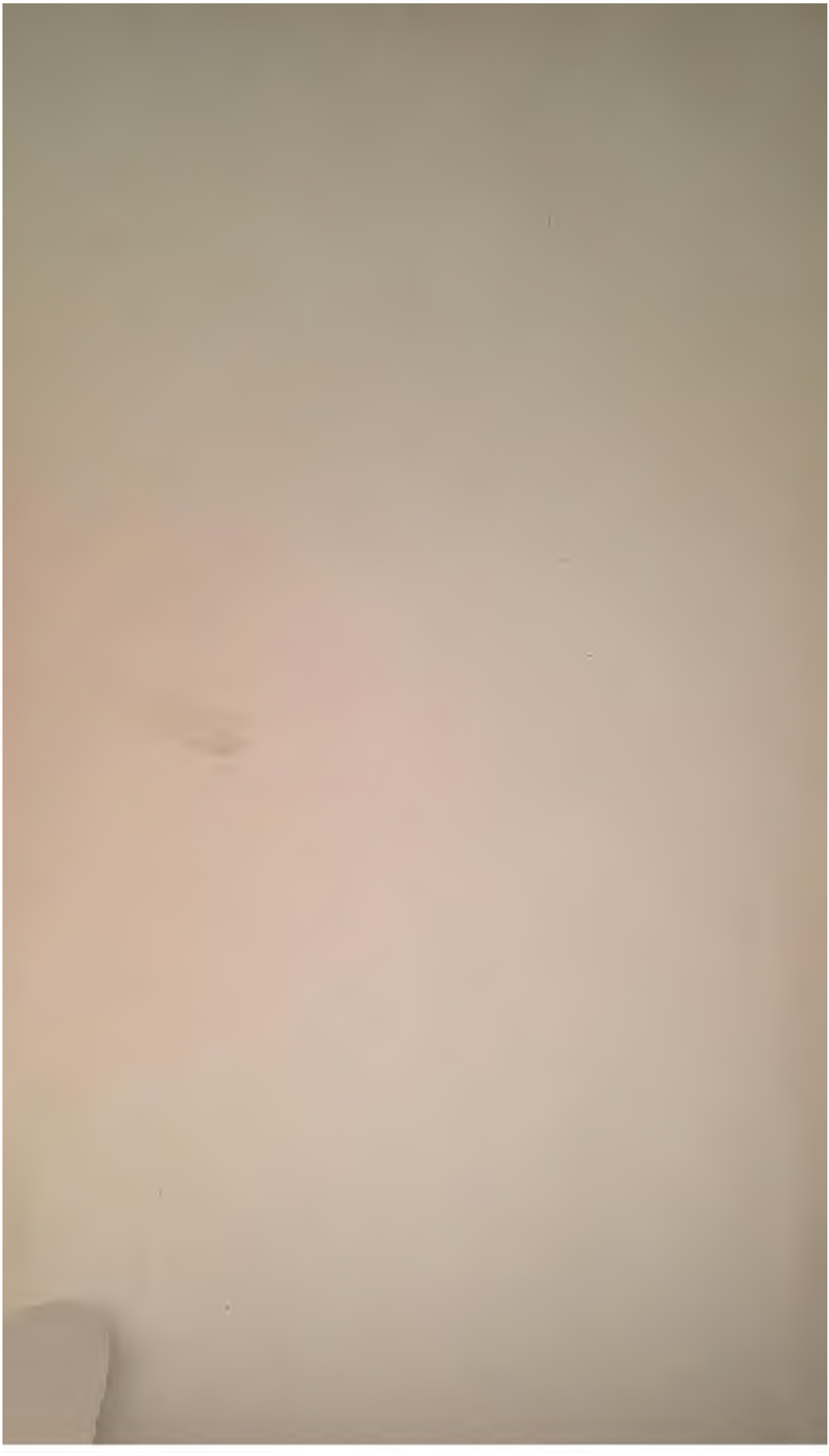
+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

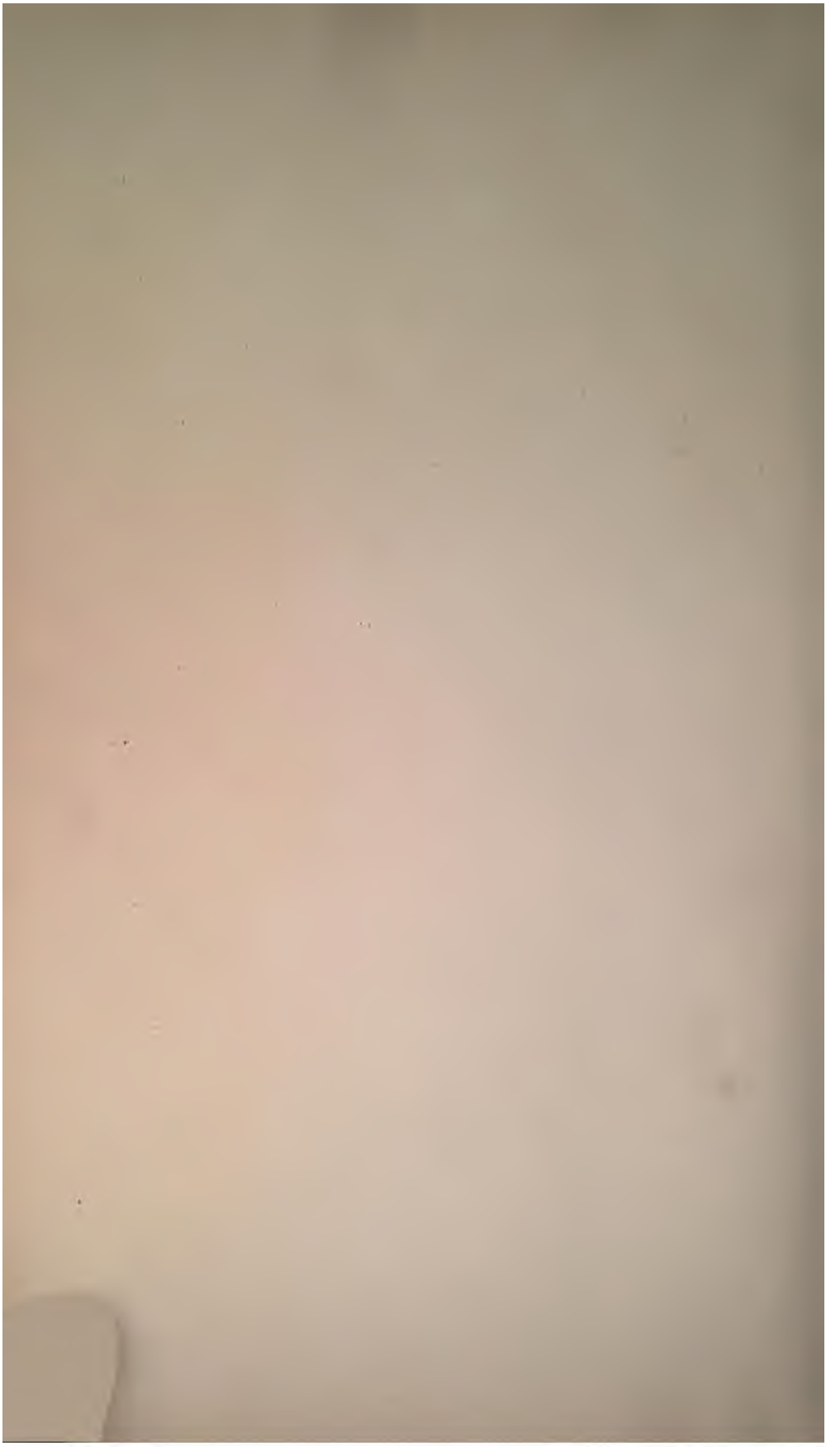
+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`





BRITISH ASTRONOMICAL ASSOCIATION.

THE

TOTAL SOLAR ECLIPSE 1905.

REPORTS OF OBSERVATIONS MADE BY MEMBERS OF THE BRITISH ASTRONOMICAL ASSOCIATION OF THE TOTAL SOLAR ECLIPSE OF 1905, AUGUST 30.

EDITED BY

F. W. LEVANDER, F.R.A.S.

LONDON:
PRINTED AND PUBLISHED FOR THE ASSOCIATION
BY EYRE AND SPOTTISWOODE,
HIS MAJESTY'S PRINTERS.

1906.

Price to Non-Members One Shilling and Sixpence.

British Astro

BRITISH ASTRONOMICAL ASSOCIATION.

THE TOTAL SOLAR ECLIPSE

1905.

REPORTS

OF THE

TOTAL SOLAR ECLIPSE OF 1905, AUGUST 30.

Introductory.

For several months previous to the solar eclipse of last year, efforts had been made by the British Astronomical Association to organise an expedition to observe it at some suitable place on the central line of totality, as had been done on several previous occasions. In the arrangement of such an expedition so many factors have to be taken into consideration that it becomes a matter of very great difficulty. One of the most important points to be determined in the choice of a place for observation is the probable state of the weather at the time of the eclipse. This involves the careful study of meteorological reports for preceding years. When an apparently suitable place has been selected, the means of conveying thither a body of observers and their instruments must be considered together with the probable expenses. It is only then that the director of the proposed expedition can put forward a feasible plan and enter upon the next difficulty—that of learning who will form the expedition. The difficulties, indeed, commence with the inception of the design and do not end even with the return of the expedition.

A skilled director, therefore, and one accustomed to eclipse work is necessary to organise such an expedition. Such a one was found in the person of Mr. E. Walter Maunder, whose experience in eclipse observations is almost unique. After many inquiries it was determined to make Burgos the head-quarters of the expedition. Shortly before the eclipse, however, Mr. Maunder was invited, together with Mrs. Maunder, by Sir Wilfrid Laurier, Prime Minister of Canada, to join the expedition which the Dominion Government was sending out to Labrador, and Mr. C. Thwaites, who had observed several total solar eclipses, undertook to act in his place and lead the expedition to Burgos. This town is situated about 140 miles north of Madrid on a plateau 2,700 feet above the sea, and almost exactly on the central line. The duration of totality was $3^m\ 45^s$.

But there were some Members of the Association who preferred to observe the eclipse from a ship's deck. After a considerable amount of trouble an arrangement was made by Mr. G. F. Chambers for those Members and their friends who desired it to proceed on board the s.s. "Arcadia," whose owners,

(the P. and O. Company), had kindly undertaken to anchor the ship during the period of eclipse. The ship hove to in lat. 39° 48′ N. and long. 0° 40′ E. The duration of totality was $3^m\ 37^s$.*

Others, again, selected their own points of vantage.

On the return of the expeditions the various reports were handed over to Mr. Thwaites, who kindly undertook to edit them. But the climate of Spain had a disastrous effect on his constitution, and after some months of ill-health he was obliged to give up all idea of accomplishing the work. Under these circumstances the present collection of reports has been undertaken by the Editor of the Association, who, unfortunately, had not the advantage of observing the eclipse. Some of the reports have been given in full, others only in abstract, while others, again, have been utilised in a less degree. The use of the Index will obviate any inconvenience that might be thus caused. Had it been possible, the Council would gladly have published all the reports in full. They trust the various observers whose reports are not printed will accept the plea of "exigencies of space" as an excuse for their non-appearance.

Four Members of the Liverpool Astronomical Society observed the eclipse at Burgos, and one from the deck of the s.s. "Arcadia." Of these five three are also Members of the British Astronomical Association. The leader of their Burgos party, the Rev. R. Killip, has kindly allowed abstracts to be made from his report published in the "Transactions of the "Liverpool Astronomical Society." The Editor is also indebted to Mr. Dickson for permission to reproduce and describe his flash spectrum photograph; to Mr. John H. Gear, F.R.P.S., who has most kindly permitted the reproduction of some of his photographs; to the Treasurer of the Association, Mr. W. H. Maw, President of the Royal Astronomical Society, and the Rev. T. E. R. Phillips for assistance in the selection and reproduction of the illustrations. To each and all of these gentlemen he desires to tender his thanks.

The volumes containing the reports of the expeditions organised by the British Astronomical Association to observe the total solar eclipses of 1898 and 1900 were published respectively in 1899 and 1901, and may still be obtained.

The meetings of the Association are held on the last Wednesday of each month from October to June, inclusive, at Sion College, Victoria Embankment, E.C. All inquiries should be made of the Assistant Secretary, 85, Gracechurch Street, London, E.C.

---

* With respect to making serious eclipse observations on board a ship Mr. F. W. Longbottom says "Our ship was as steady as one could ever be, "but very little exact work would have been possible. The dilettante "astronomer will find the experience most enjoyable. From a scientific "point of view I am afraid I must regard the trip as a wasted opportunity."

REPORTS.

By the DIRECTOR of the EXPEDITION to BURGOS, Mr. C. THWAITES, F.R.A.S.

As the Hon. Secretary of the Eclipse Committee and leader of the expedition to Burgos, Spain, I made arrangements with the Foreign Office as to customs, &c., and sent a number of our printed labels with the request that they might be forwarded to His Majesty's Ambassadors at Paris and Madrid, for distribution to the different ports of entry and departure. Difficulties arose as to France; but at the last moment, after several lists had been sent in of the members of the various expeditions, with their destinations, ports of arrival and departure, with the dates of the same, letters were received to facilitate our passage, and these, together with the printed labels, acted as passports, so that all our baggage was passed through unopened. Although

TYPICAL COUNTRY SCENE NEAR BURGOS.
From a photograph by Mr. John H. Gear, F.R.P.S.

twenty members had sent in their names for the expedition, this number was not maintained; several fell off as the time approached, until only thirteen names remained. After much correspondence seventeen were secured, five being ladies, and another joined us at Burgos. As the result of some negotiations with our conductor, Mr. John H. Gear, F.R.P.S., a substantial allowance was made by the Polytechnic Touring Club, so that our expedition was carried through for the amount originally provided.

Our conductor arranged all payments and details as to travelling and hotels, and carried out his work to our entire satisfaction, for which, in letters to himself and the Polytechnic, I expressed our thanks.

The journey to Burgos, which took some 36 hours, was too long for ordinary endurance, and might, with advantage, have been broken at some intervening town. At Burgos we were met by Lieut. Liduana, of the 7th Lancers, and Señor Veza, a deputation from the Reception Committee of the City of Burgos, who escorted us in carriages to our hotel. These gentlemen spoke English, and assisted us in every way during our stay in the city, and I expressed to them our most grateful thanks.

The Alcalde, Señor Josè Plaza Iglesias, gave an official reception, to which all the astronomers of the different nationalities were invited, and the city was gaily decorated for the visit of H.M. the King of Spain.

KING ALFONSO VISITING MR. THWAITES'S PARTY.

From a photograph by Mr. John H. Gear, F.R.P.S.

Meetings of our party were held to ascertain what instruments had been brought, the line of work which each person wished to undertake, and to arrange for the distribution of the work during the eclipse. The various instruments were quickly erected and

adjusted on the Campo de Lilaila, distant rather over two miles from the city, which had been selected for us by Señor Iñiguez, the Chief of the Royal Madrid Observatory; the Spanish Government providing us with a tent with its furniture, and a guard of soldiers.

On the day before the eclipse a full rehearsal was held, during which, and quite unexpectedly, H.M. the King of Spain drove up to the camp, and after an inspection of the instruments of the Spanish and some other astronomers, came to our camp, and asked me to explain to him our different instruments, their objects and their uses, which I did. He spoke excellent English, showed the most intelligent interest in our proceedings, asked many questions, and was most gracious in his behaviour to the whole of our party. I took the opportunity of thanking him for the assistance which the Spanish Government, Señor Iñiguez, and the Municipality of Burgos had rendered us, and he replied: "I am glad, for I have "given orders for everything to be done for your comfort, and for "the instruments which you have brought."

The early morning of the 30th August was fine and clear, but clouds soon appeared, which almost entirely covered the sky. The first contact could not be seen, and we feared that the sun would either remain entirely covered, or be seen only for short intervals. I, therefore, changed my plates for others of a more sensitive make, having determined to carry out our programme as to counting, &c. I had carefully adjusted my metronome to beat seconds within a small percentage of error, and my watch had that morning been twice compared with the time as furnished to us by Señor Iniguez.

Everything was in readiness and we awaited the result with intense anxiety. As the time of totality approached, I stood by, watch in hand, warned our party to preserve strict silence, took rapid glances round the landscape, and then saw the shadow-bands on the roof and sides of our tent, as well as on the sheet spread alongside. At the calculated second, I gave the signal "Go," starting the metronome at the same moment. The sun remained covered with clouds up to within 15 seconds before the signal was given, when suddenly the clouds were noticed to be disturbed and a rift appeared, which most fortunately lasted for about five minutes, or one minute longer than totality.

The corona was of a pearly white colour and not so bright nor were the rays so long and distinct as in the 1898 eclipse; it was a typical sun-spot maximum corona. Before totality a splendid display of prismatic colours was noticed on the edges of a cloud, which formed the border of a rift to the south-west of the sun, and Venus was seen at once when uncovered by the clouds. The clouds certainly added to the grandeur of the scene. There was a noticeable fall in the temperature. A shower of rain fell shortly before totality, and was so heavy that Mr. Bruford, who kindly assisted me at the telescope, had to shelter my note-books with an umbrella.

Miss Berry undertook the duty of counting, which she carried out most satisfactorily. The duration of totality was 3 minutes 45 seconds; 5 seconds after its commencement, 3 minutes 40 seconds was called, then, 10 seconds later, 3 minutes 30 seconds

and so on, up to the last 10 seconds, which were called separately 10, 9, 8, &c. By this means we all knew, at any moment and without calculation, the time which remained at our disposal.

The shadow-bands were again seen after totality, and were more distinct. They were faint, delicate lines with softened edges which swept across at regular distances with a tremulous or vibratory motion.

The Campo de Lilaila is situated, according to Señor Iniguez's determination, in—

Latitude N.	-	- $42^{\circ}\ 20'\ 3''$.
Longitude W.		- $14^{m}\ 41^{s}\cdot 1$.

By the Rev. T. E. R. PHILLIPS, M.A., F.R.A.S.

(At Burgos.)

The meteorological conditions during the morning were very unpromising, as, though the sky quite early was cloudless, it was not long before ominous strips of cirro-cumulus, moving quickly from W.S.W., made their appearance in the North and gradually spread in all directions. These were followed later in the morning by detached clouds of the cumulus type, which, though at first stationary, developed with considerable rapidity, and threatened to make observations of the eclipse impossible. How nearly they succeeded in accomplishing this may be gathered from the fact that from $0^{h}\ 45^{m}$ to $1^{h}\ 30^{m}$ (G.M.T.) the sky, on the average, was more than three-fourths covered, and that a rain squall with its centre passing to the north of us set in just before one o'clock, and did not really cease till within about a couple of minutes of the commencement of totality. A small patch of blue, which had been observed slowly moving towards the sun from the westward, then appeared to open up and expand in almost miraculous fashion, and a view of the whole of the total phase was unexpectedly obtained. Further particulars of meteorological phenomena, observed at intervals of a quarter of an hour during the progress of the eclipse, will be found on another page. The most noteworthy feature is the very large drop in temperature of just 14°.

The first contact, which was timed to take place about $23^{h}\ 46\frac{1}{2}^{m}$ (G.M.T.) was missed in consequence of clouds, but a few minutes later the sun re-appeared, and the outline of the moon's limb was seen clearly and sharply defined against the solar surface. A long break in the clouds permitted the progress of the eclipse to be watched for some time, but the only points of interest were the passing of the moon over a sun-spot and the gradual alteration in the colour of the sky and landscape. Towards the end of the partial phase a broad clear streak above the western horizon seemed to change from a pale blue to a distinct sea green, and the waning light gave everything a weird and peculiar appearance, which I cannot well describe. About 25 minutes or so before totality dense clouds had rolled over the sun, and further observations of the eclipse were prevented till the above-mentioned rain squall was passing off. The extremely narrow crescent of the sun was then seen through a veil of thin

cloud, and a moment or two later a large patch to the S.W. of the sun, with its centre roughly 8 or 10 diameters distant, glowed with the most beautiful prismatic colours. It may be worth mentioning that these colours did not appear to be fragments of concentric circles, but irregular patches like the colours of mother-of-pearl. Just previously Venus had emerged from cloud, and shone as an intensely brilliant point on a background of deep blue. I then hastily made my final arrangements for exposing a plate for the flash spectrum. While doing so, I turned towards the N.W. and caught a glimpse of the shadow approaching in the distance, almost like a heavy thunder-cloud. The spires of Burgos Cathedral and the castle hill behind the town still stood out

BURGOS CATHEDRAL.

From a photograph by Mr. John H. Gear, F.R.P.S.

clearly in the quickly fading sunlight, but half a minute later the shadow had swept over and enveloped us. Nothing could be more impressive than the sudden contrast between the sunlight—which, even to within a small fraction of a minute of totality, struck me as considerable—and the darkness of the shadow.

I did not see the first appearance of the corona. At the time I was watching the sun through a Thorp grating prism attached to one of the objectives of my binoculars for the spectrum of the chromosphere and the flash spectrum of the "reversing layer."

With such apparatus these very beautiful phenomena can be readily observed, since the layers of gases seen in profile round the sun's limb are so narrow as to give a sufficiently pure spectrum without the necessity of using a slit.

It is worth recording that the corona certainly became visible a few seconds before totality had actually commenced, for someone near by exclaimed "The corona," while the bright strips of continuous spectrum caused by Baily's Beads were still in evidence. At the same time Mr. Thwaites gave the signal "Go," and this was followed a few seconds later by the clear voice of Miss Berry, who had kindly consented to act as time-keeper and announce the number of seconds remaining at the expiration of every ten.

During totality I exposed five plates with the kind assistance of Mr. Raisin; made observations of the general appearance of the corona; looked for Mercury, which I failed to see (possibly in consequence of cloud at the moment); read the thermometer, and noted the magnificent colour effects on land and sky. Certainly the heavy clouds which during the morning had caused us such anxiety, and indeed shortly before totality such despair and disappointment, in the end enhanced enormously the grandeur of the spectacle. For a moment or two I looked towards the west, and saw that the clear streak of sky above the horizon now glowed with rich golden yellow or orange, the effect, doubtless, of the returning light in the distance beyond the shadow.

In these observations the precious $3\frac{3}{4}$ minutes quickly passed, and then came the first visible intimation of the end of totality in the sudden appearance of a beautiful star-like point of the most dazzling silvery light at the western edge of the moon. This rapidly spread round the limb on that side and the light had returned, but for a few seconds yet I distinctly saw the corona on the side opposite the sunlight.

It may not be out of place to mention here that, as the sunlight reappeared after totality, our feelings of thankfulness and delight at our unexpected good fortune found expression in a hearty burst of applause and much mutual congratulation.

The observations during the passing off of the moon were naturally of little interest, but I continued my meteorological notes till 2.30 p.m.

The last contact at $2^h\ 27^m$ (G.M.T.) was not observed in consequence of clouds.

I have no data for comparing this eclipse with others, but it seems to have been a fairly dark one. It is true that scarcely any stars were visible, but only a small portion of the sky was clear at the time. Some idea of the degree of darkness may be gathered from the fact that I had a difficulty in reading the thermometer at mid-eclipse, though the instrument was taken from its shelter, and the scale-divisions were clearly marked and widely separated.

By Mr. E. Howarth, F.R.A.S.
(At Burgos.)

The morning of August 30 opened with a perfectly clear sky, from which the stars and planets seemed loth to depart, their brightness being incomparably greater than under the most favourable conditions in England. On arrival at Burgos about 6 a.m. the sky still remained cloudless, giving every prospect of an uninterrupted view of the eclipse later on. About 8 a.m., however, clouds began to appear in the form of thin cirro-cumuli, travelling rapidly from the south-west, their motion being unusually fast for this form of cloud. Just before the first contact a cloud travelled in front of the sun, and remained long enough to hide the beginning of the eclipse, which, therefore, could not be observed. But two minutes after the time of first contact the sun was once more clear, and the moon was plainly perceptible on its north-western limb. There was no important change in the light until the sun was half-covered, when the atmosphere became perceptibly darker, and the blue of the sky deepened considerably. So far the sun had remained fairly clear of cloud, the light wisps that occasionally passed in front of it never completely hid it, and only dimmed it for a short time. The air now became appreciably colder, and the light gradually faded, though it was still abundant enough to make everything plainly visible, even the pinnacles of the cathedral at Burgos, some three miles away. Twenty minutes before the time of totality a long streamer of cirro-stratus cloud travelled from the north-west in front of the sun, with a clear space behind it, though its passage appeared so slow as to cause some anxiety as to whether the commencement of the total phase would be seen. The air now felt almost chilly, in comparison with the previous heat; the sun was quite obscured, and doubtless the clouds partly contributed to reduce the temperature, already affected by the eclipse. Shortly before 1 p.m. there was a smart short shower, with a marked change in the cloud formation immediately in front of the sun. Two minutes before totality this patch of cloud disappeared, leaving the sun perfectly clear against the blue sky. Ten minutes previously Venus had been plainly visible to the west of the sun. My attention was at once directed to the westward in order to observe the shadow advancing, and I was struck by the darkness of the sky in the north-west, where there were some streamers of stratus cloud, which had become of a hard metallic yellow colour, while to the south-west neither sky nor cloud was visible, but only a dense wall of blackness, which seemed to be rushing towards me. The estimated time during which I saw it was about 10 seconds, sufficient to allow me to call the attention of others at hand, who were equally impressed with the awful sublimity of this mighty rush of visible blackness.

I did not note the time of second contact. The first impression of the total phase was that the corona was not nearly so bright as in 1900, when I saw the total eclipse at Navalmoral, and that the atmosphere was much darker than on that occasion. Looking at the eclipsed sun for a few moments with the naked eye, the

corona appeared to me to have few streamers; there were two conspicuous prominences on the eastern limb. Using a strong pair of opera glasses, I noticed a long streamer on the north-western limb near the first point of contact, this being the longest streamer, and nearly equal to the sun's diameter; to the north of this were two shorter streamers, and below it were two other short ones. Further down near the southern limb was a very broad streamer, almost equal in length to the first one

THE PINNACLES OF BURGOS CATHEDRAL.
From a photograph by Mr. John H. Gear, F.R.P.S.

mentioned. Round on the south-east were two fairly long conspicuous streamers, then a space of tolerably even corona up to the north-eastern quadrant, where there was a conspicuous prominence, and another slightly larger above it, the height of these being equal to about one-eighth of the solar diameter. Beyond them to the north was a tolerably even band of the corona, extending rather higher than the similar even band to the south of them. These positions are all in relation to the visible sun, and not to its actual cardinal points. I watched the sun through the glasses for a minute, then made a rough drawing of it. It seemed to me that the light of the corona varied in intensity at different times during totality, giving the impression

of an undulatory motion from the chromosphere outwards—not that any such motion was really visible, but the varying light was suggestive of it. The prominences were visible for less than a minute. Generally speaking, the corona showed more extensions on the western than on the eastern side; it was distinctly fainter than in 1900, with shorter and narrower streamers, and the light during totality was not nearly so strong as in 1900. The reappearance of the sun after the end of the total phase was like a detached bead of light, and at the moment of its appearance I again looked for the shadow, which I very plainly saw retreating eastwards, looking less black than when it came, its passage marked by the rapidly appearing sky in front of it. It was not visible after totality for more than five seconds. During the progress of the eclipse I took several photographs of the camp to mark the diminution of light, and the resulting negatives show details quite clearly up to an hour after the first contact, and a photograph taken five minutes after totality is also clear.

By Mr. H. KRAUSS NIELD, F.R.A.S.

(At Burgos.)

I was asked to lead the Members of the British Astronomical Association who went, *viâ* the Thames, by the General Steam Navigation Company's boat to Bordeaux, there joining the Sud Express,

MR. H. KRAUSS NIELD'S PARTY AT BURGOS.

and arriving at Burgos on the morning of the eclipse. After wasting two valuable hours on our arrival, over my box of instruments, which the Spanish railway officials had put in the wrong train at

Irun, and after literally fighting for our breakfast, we made our way to the observing station.

Never shall I forget the dramatic way in which the clouds cleared off the sun at the last instant. When it began to rain just a few moments before totality was due, everyone was filled with consternation; it seemed that we were not to see the total phase. The average Englishman is, however, nothing if not phlegmatic, and I tried to hide my feelings by observing how the astronomers of different nationalities would take the calamity. The Germans were philosophic, characteristically enough, and some even went so far as to commence taking down their instruments, while a few Frenchmen not very far from me appeared excited and irritated; they seemed to suggest that it was impolite of the clouds to be so aggravating. Some of the Spanish, I was told, were insulted and looked very much as if they would like to attack somebody or something. Very interesting were the members of the American party from Harvard University. They were just in front of me, and one in particular, who I afterwards learnt was not a scientific member of the party, looked very superior to all that was going on, and unless my imagination much deceived me, he was saying as plainly as looks could say, that it was a very badly managed job and, if only the eclipse had been run in New York, there would not have been a single cloud within a hundred miles of the city during the whole day.

MR. A. WEBB, MR. C. ARTHUR PEARSON, AND MR. H. KRAUSS NIELD WITH THE NIBLETT CAMERA.

Perhaps I am biassed in favour of the Members of the British Astronomical Association; their attitude seemed to express that the eclipse was not over yet, and that they would never say die until it was actually and completely finished; at any rate, as is well known, we *did* see the whole of totality.

I used the Niblett 4-in. lens of 36 inches focus, lent to me by the Association, and succeeded, with the help of Mr. A. Webb, who kindly went out as my assistant, in getting eight negatives of the corona. At the beginning and at the end of totality I worked at *f* 18, using an aperture of two inches and exposing my plates for one-sixteenth of a second. The other plates were exposed for one-twelfth, one-fourth, and half a second respectively, with the full aperture of four inches, and, thanks largely to Mr. E. Walter Maunder, who kindly helped me to develop my plates, all the negatives show a fair amount of detail.

I had, however, principally set my heart on attacking the problem of photographing the corona as long before or after totality as possible; but the clouds, which passed from the immediate neighbourhood of the sun for only the exact time of totality, absolutely spoilt this particular work. I exposed three plates before and three after totality, all specially prepared, with the ambitious idea that they might possibly give a hint as to the direction in which we shall have to work, if we are ever to photograph the corona in broad daylight.

In my opinion the eclipse was sufficiently darker than that of 1900 at Algiers to be noticeable, and this was also the opinion of several French and Spanish astronomers whom I questioned on the subject.

By Mr. W. B. GIBBS, F.R.A.S.

(At Burgos.)

The first contact was well seen, but during the partial phase the clouds still kept growing, until at about 20 minutes before totality there was but little clear sky left in the neighbourhood of the sun. Slight rain began to fall, so that observers had to cover up their instruments with handkerchiefs or any stray cloths that happened to be at hand.

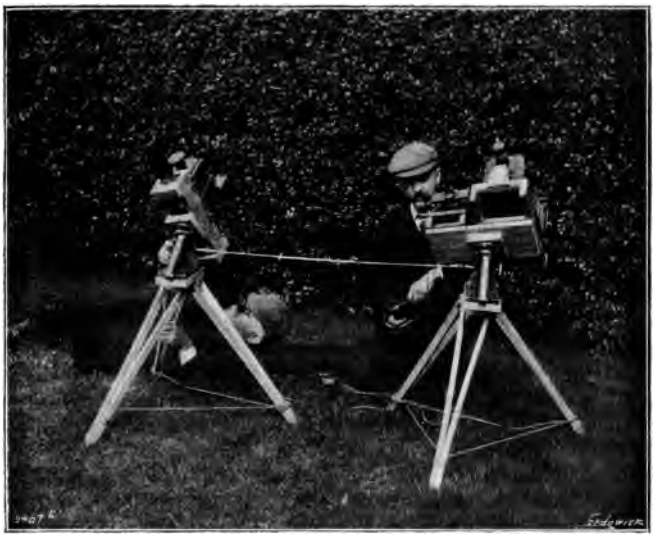
Five minutes before totality matters looked very unpromising. Then in the last minute or two a wind sprang up, rolling away the heavy clouds and unveiling for us the thinnest of solar crescents in a large space of sky, so free from cloud that we knew observations could be successfully made. My instrument was only a large-size prismatic binocular, one tube of which was fitted with a Thorp grating. On looking through this at the thin solar crescent, I saw dull curved markings in the spectrum, which quickly sharpened up into the Fraunhofer lines, changing in a few seconds into a flash of bright lines. I then with my small camera exposed two plates for the corona; unfortunately, these have not been successful. Around the black moon could be seen the solar corona of the type belonging to the maximum sun-spot period. I did not estimate it to be so bright as those I had seen in India and Portugal. The chromosphere and prominences could be plainly seen, fringing the N.E. quadrant of the moon. Venus was seen six minutes before totality through a rift in the clouds; Regulus was faintly seen; Mercury was looked for, but not seen. On looking round at the sky, I saw in the west a large wall of dark purplish shadow. Near the horizon in the gaps

between the clouds, which were tinted with every variety of bluish grey, were deeply coloured orange spaces. The first appearance of the returning sunlight looked like a bright electric arc-light hanging to the edge of the dark moon. So passed the 1905 eclipse.

By the Rev. R. KILLIP, F.R.A.S.

(At Burgos.)

It was originally intended to form a strong party, charter a steamer from Liverpool, and take up a position on the north coast of Spain, not far from Corunna. The idea had, however, to be abandoned, and members were left to their own resources. Mr. D. E. Benson, of Southport, and myself, accordingly, went together to Burgos. Our time being somewhat limited, and our intention being to arrive at Burgos only on the morning of the eclipse, it was necessary to devise apparatus for the purpose of photographing



REV. R. KILLIP AND MR. D. E. BENSON.

the corona and the flash spectrum that could be easily and quickly set up and adjusted. This consisted of two equatorial stands, to each of which was affixed a block cut to the angle of the sun's declination on the day of the eclipse. One stand carried a 2-in. guiding telescope and an ordinary quarter-plate camera, with a Sanger-Shepherd green screen, for exposure during the whole of totality. The other mount was furnished with two cameras, one

for varying exposures through coloured screens, the other with a telephoto lens working at f 11 × 8 = f 88. Another camera was mounted specially to obtain photographs of the flash spectrum. The two equatorial mounts were connected by a rod by which a simultaneous movement could be imparted to both. For visual observation of the flash I was provided with a Lemaire binocular with a Thorp plane grating in front, Mr. Benson with a Goertz prism binocular, with a Thorp grating on a prism. The party occupied a position close to that of the members of the British Astronomical Association's expedition.

The flash was well observed visually, and with the telescope six prominences were seen on the east limb, quite distinct and separate, as well as others on the western. The shadow-bands were distinctly visible for several seconds, though no special provision had been made for observing them. During totality the light was estimated to be rather more than that of the full moon; the seconds hand of an ordinary watch could be seen without difficulty.

THE CORONA, AUGUST 30, 1905.
From a photograph by the Rev. R. Killip.

The photographs of the corona, though on a small scale, show, when carefully examined with a lens, a considerable amount of detail, more of which is visible on the negatives themselves. Unfortunately, we were not successful in photographing the flash spectrum.

By Mr. A. C. D. CROMMELIN, B.A., F.R.A.S.

(At Palma, Majorca.)

The following were the observed Greenwich mean times of the beginning of the eclipse, and the beginning and end of totality, the predicted times of Señor Iniguez and Prof. Todd being given for comparison :—

Greenwich Mean Times.

——	Observed.	Iniguez.	Todd.
	h m s	h m s	h m s
First contact - -	0 0 52	0 1 3	0 0 52
Totality begins - -	1 21 23	1 21 51	1 21 26
„ ends - -	1 24 31	1 24 51	1 24 34
Last contact - -	Not observed.	2 39 57	2 39 35
	m s		m s
Longitude East of Greenwich.	10 35·8	Exact point not indicated by	10 52
Latitude N. - -	39° 34′ 12″	Iniguez, but	39° 37′
Height above sea -	About 80 feet.	probably nearly same as last column.	

The time was obtained by the dropping of the time-ball on H.M.S. "Venus," in combination with sextant observations of my own, the two being in good agreement.

It will be seen that the longitude and latitude selected by Todd are not those of the town of Palma, but refer to a point about four miles N.E. of the town. Curiously enough, in spite of this error, his predicted times agree very closely with the observed ones. The actual time noted for first contact was 3 seconds later than that given, but, as the moon had already visibly encroached on the sun, I concluded that the true contact must have been about 3 seconds earlier.

The beginning of totality was observed by watching the disappearing solar crescent projected on a screen behind the eye-piece of my telescope. Baily's Beads were very well shown by this method, and formed a beautiful spectacle. I still adhere to the opinion that I formed in the 1900 eclipse, that these "beads" are simply the lunar mountains seen in profile, their seeming enlargement being due to the widening of the solar crescent by irradiation.

During totality I took two photographs with a portrait lens, kindly lent by Mr. Maunder. These clearly show the prominences and the inner corona, also the bases of the principal streamers, but very little extension of these owing to obscuration by thin cloud. For the remainder of totality I observed the corona through an excellent binocular lent by Miss E. I. Page. The general aspect is well shown in a drawing by Major Baden-Powell

in "Knowledge," October 1905. The prominences and inner corona were exceedingly brilliant, the latter to my eyes appearing of a bluish white, so bright that I could quite understand how Kepler took it for a part of the sun, and imagined that the sun could never be totally eclipsed. The unusual brilliance of the corona is further established by the fact that Mr. Hodge saw the moon's limb plainly projected against it quite 1′ outside the sun about 35 minutes before totality.

There was far more light than I expected during totality, and the small figures of a watch and thermometer were easily visible. This differs from the experience of observers at other stations; perhaps the fact that we were a long way north of the central line had something to do with it.

I wish to tender my thanks to Mr. Gavin Burns and Prof. Leahy for kind assistance in giving and registering signals, and to Mr. Allen for time-keeping. Though we secured only a partial success, we found our stay in Majorca very enjoyable. The Grand Hotel was extremely comfortable, and the manager, M. Albareda, most obliging.

By Miss ALICE EVERETT, M.A.

(At Palma.)

The morning of the 30th was cloudy. Before noon several of us went on the roof of the Grand Hotel to see the 12 o'clock ball drop on H.M.S. "Venus." At about 5 minutes to 12 the clouds cleared, and the sun came out so brightly that I hastily fetched a hat, fearing "a touch of sun." After seeing the ball dropped, I went below to observe from the window of my room. All Palma seemed to be on the flat house-tops, and, as soon as the sun became visibly encroached on, a great shout went up from the people, a universal cry, which was very striking. The sun continued to shine strongly till a very few minutes before totality. As totality approached, I watched the projected image of the sun on a card held behind a 2-in. telescope to avoid dazzling my eyes. Suddenly the image was obscured by light clouds, the out-fliers of a great bank rising rapidly from the Sierras, which I now noticed for the first time, and with alarm. It was a near thing, but the cloud won, the edge of the bank reaching the sun a very few minutes before second contact. Now came the sudden rush of gloom, announcing totality. And there was the dark moon with a halo round it. The following are notes made on the spot, a quarter to half-an-hour after totality:—

"Sun was covered by heavy cloud a very few minutes before "totality. After several seconds corona became visible through "cloud, appearing fairly symmetrical to naked eye. No streamers "observed, cloud interfering with view. It remained, I think, "partly visible through cloud till flash of returning sunlight was "seen.

"The view to naked eye was not very impressive, as clouds "prevented it being seen properly.

"Directly a part of the corona was seen I exposed, and gave "three exposures of 20 seconds each. Last exposure was over-

" taken by returning sunlight. There was then a short break in " clouds, and I gave two instantaneous exposures, the first with " the grating still on, the second, much later, with grating off. " One of these was at $1^h\ 27^m\ 53^s$ G.M.T. Sun then disappeared. " Looked for last contact, but it was cloudy. When cloud cleared " enough to see, at $2^h\ 41^m\ 16^s$ G.M.T., sun was round.

" During totality it was surprisingly light. There was sudden " gloom, it is true, which was very noticeable, but the fact that " a cloud had just covered sun made it less of a surprise. It was " not much darker than a very heavy cloud would have made it. " I could see to handle instruments easily. I had a candle, but " hardly needed it."

The Palma experiences furnish a warning against over-concentration. Nearly all the astronomers who went to Majorca observed from Palma, where the eclipse was cloudy, while places a few miles off had it clear; so that a little spreading of observers would probably have meant a good deal more in results.

By Mr. R. HODGE.

(At Palma.)

I especially noticed during the partial phase mountains on the moon's limb, the blunting of the sun's horns, and the visibility of the moon's limb against the sky 35 minutes before totality. A large number of observers appear to have seen the mountains on the moon's limb, but there seems to be some doubt as to the blunting of the sun's horns, though I have none myself. To me it was most distinct. It did not remain permanent at either horn, each coming sharp and blunt again from time to time. Once I saw the point of the N. horn as a speck of light just as the tops of mountains shown at the moon's terminator when the sun is rising on them. If it is allowed that mountains can be seen standing out on the limb, it seems only reasonable that at times they should blunt the sun's horns. There have been in the "English Mechanic" some photographs of the partial phase, but, in consequence of the method of reproduction, it is difficult to say whether the negatives show a blunting or not, but the correspondent who sent one set mentions that the photographs show the blunting.

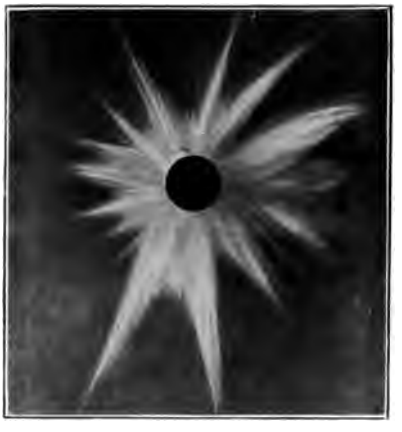
With regard to the visibility of the moon's limb against the sky, I saw it very distinctly, but only at the N. juncture: might it not have been made visible by the large prominences in that quarter? Our President saw the phenomenon as well as myself. I was using a 3-in. refractor, power 60, and a medium red cap. I took a few photographs with a Dallmeyer landscape lens of 32-in. focus at f 16, using Edwards's isochromatic snapshot plates.

By Miss C. O. STEVENS and Miss K. L. HART-DAVIS.

(At Càs Catalá, Majorca.)

Employing a 2-in. spy-glass for a projected image of the sun of about 4-in. diameter, we commenced observations shortly after 10 a.m., with a view to securing the means for a comparison of the evidences of the prevailing atmospheric conditions both before and during eclipse. A detailed report of these observations having been compiled separately*, it will suffice to say here that these, in conjunction with our observations of shadow-bands just before totality, afford striking evidence of the fact that shadow-bands are a purely local atmospherical phenomenon, and in their origin have no element of connection with the peculiar circumstances of an eclipse.

Observation of deep serrations in the moon's limb to the south of the centre of the line of advance was recorded within 15 minutes of first contact, and these were never again lost sight of throughout the phase of partial eclipse preceding totality.



THE CORONA, AUGUST 30, 1905.

Sketched by Miss C. O. Stevens at Cas Catala.

Second contact was observed with the naked eye. At the same moment the full extent of the corona revealed itself. The great length of the streamers was not immediately apparent owing to the unexpected depth of the fringe of the inner corona, but an estimation of their extent gave a result of at least $2\frac{1}{2}$ to 3 lunar diameters for the longest, that is to say, for two extending S., for one extending N.N.E., for two extending N., and for two others extending N.W. and S.W. respectively.

---

* *See* "Journal of the British Astronomical Association," Vol. XVI., p. 60.

The general appearance of the corona was that of an obviously 4-winged figure, that is to say, of the type associated with sun-spot maxima, but the very wide fringe of the inner corona made this configuration less striking than on some previously-recorded occasions.

A large group of prominences, situated high in the N.E., was conspicuous for the golden tone of its colouring, as contrasted with the electric steel-blue light of the corona. As to the height of this group, some estimation may be made of it by the record secured of the time that elapsed from the moment of the formation of Baily's Beads until the prominence was finally occulted. This lapse of time appears to have been 2^m 30^s. Other prominences were also observed in the S.W. during the last few moments of totality. There were only two noticeable gaps in the concentric distribution of the inner corona, the most conspicuous of these being immediately to the west of the north equatorial "brush" and the other, much less obvious, to the west of the southern equatorial "brush." There appeared to be a very noticeable tendency in all the upper streamers, taking them in succession round by north from east to south-west, to show a bend from the vertical to the right of the spectator. A strong impression was created in the minds of some observers of scintillation, emanating more particularly from the western quadrant. It was also noted in connection with this region that there was a conspicuous appearance of foreshortening, as well as of superimposition of the coronal rays and streamers. There were several groups of sun-spots, three of which were conveniently placed for noting the times of their occultation by the dark limb of the moon. The times of these occultations were recorded to have taken place as follows, being observed by projection:—

1st spot in touch with the advancing limb of the moon, 39^m 7^s after first contact, and completely occulted 57^s later.

2nd spot too small to record anything but the moment of complete occultation. This was timed as taking place 1^h 2^m $4^s{\cdot}6$ after first contact.

3rd spot in touch with the advancing limb of the moon 1^h 11^m 18^s after first contact, and completely occulted 56^s later.

By the Rev. A. L. CORTIE, S.J.

(At Vinaroz.)

The members of the Stonyhurst expedition were myself, with Mr. Aidan Liddell as chief assistant, and two former pupils, Mr. Louis Cafferata, a Member of the British Astronomical Association, and Mr. Gonzalo de Aguilera. Two days before the eclipse we were joined by Father Morford, of Saltash, also a Member of the British Astronomical Association, who made

visual observations with a 4-in. refractor, and was responsible for giving the signals "Go" and "Close" at the beginning and end of totality. The instrumental outfit consisted of a 4-in. photographic objective of 19 ft. 4 ins. focal length, fed with light by an 8-in. mirror on a cœlostat mounting. These instruments are the property of the Royal Irish Academy, and were lent for the occasion through the kind offices of the late Royal Astronomer of Ireland, Prof. C. J. Joly. There were also three spectrographs used, but with only partial success. The expedition was stationed at Vinaroz, latitude 40° 28′ N. and longitude $1^m\ 56^s$ E.

THE CORONA, AUGUST 30, 1905.
From a photograph by the Rev. A. L. Cortie, S.J.

The weather on the day of the eclipse was at first brilliantly fine, but as totality approached a great bank of clouds arose from the south-west, and detached thin clouds continued to pass across the face of the eclipsed sun during nearly the whole of totality. Six photographs of the eclipse were obtained during the total phase with exposures of 4, 8, 15, 50, 15, and 6 seconds, the first, second, fifth, and sixth being on backed Imperial Ordinary plates, with a speed 88 on the scale of Hurter and Driffield. The third and fourth photographs were on Dr. Schleussner's Rapid Observatory plates, of which the speed number has not been ascertained, the Watkins number for three similar batches of plates, however, being 90, 86, 100. The size of the image of the moon on the plates is 2·1 inches. In the fourth

plate the long coronal streamers extend to the limits of the plate, and a much larger one could have been used with advantage. The plates were developed in England by Mr. William M'Keon, the developer used being pyro-soda. Besides a certain amount of fog, due to the passing clouds, there is fog on the plates and images of the grain of the wood of the slides owing to transporting the plates from Spain to England in the plate-holders. The chief features on the plates are a great group of prominences on the east limb surmounted by a complicated structure of arches, and in the last photograph by a vortex ring, a well-marked dark ray, and a group of bright plumes in the south-east quadrant, a system of straight light rays in the south-west quadrant, and a fine set of streamers, especially in the north-east, north-west, and south. A detailed study of all these phenomena is appearing in the "Transactions of the Royal Irish Academy." One interesting result is that, besides the corona being of a decided maximum type, similar to those of 1882 and 1893, it is very probable that the dark ray and plumes on the south-east converge to a position previously the seat of the great sun-spot of February–March 1905.

The plate reproduced is the last, exposed for 6 seconds, the exposure terminating about 10 seconds before the end of totality.

Mr. Louis Cafferata was chiefly impressed by the extreme brightness and uniformity of the inner corona, and by the groups of prominences on the N.E. of the sun's limb. He was engaged in manipulating the transmission-grating camera, and he reports that light clouds were drifting across the sun for practically the whole time of totality.

Mr. Aidan Liddell had a view of the prominences visible at the end of totality on the ground glass of the 20-feet coronagraph. Their colour appeared to be pinkish, with a decided tinge of a violet hue.

By the Rev. AUGUSTIN MORFORD.

(At Vinaroz.)

I had been staying for some days near Bordeaux. I started for Spain from the Gare du Midi on Sunday evening, August 27th, at 6.42, and reached Vinaroz at 2.45 p.m. on Monday, after a much less difficult journey than I had expected. I received great courtesy from the chief officer of Customs at Port Bou, the station on the Spanish frontier.

Father Cortie was at the station of Vinaroz. He took me to the *fonda* (hotel), where I slept during my stay, and to the house of Dr. Sebastian Roca, where we took our meals in common. Our observation ground was in a field of lucerne adjoining Dr. Roca's garden. A gap had been made in the wall of separation for our convenience.

Father Cortie had brought three helpers with him, and enlisted a number on the spot, including our host, Dr. Roca, whose genial enthusiasm and exquisite courtesy charmed us all. At 4 o'clock a general rehearsal took place. Father Cortie had

three instruments for photographing the spectra in different ways, and a camera for the corona, of about 20 feet focal length.

I, having brought the only telescope, a refractor of $4\frac{5}{16}$-in., and intending to make only visual observations, was appointed to give orders to open and close cameras at the beginning and before the close of totality. My own observations were made with an eye-piece having a magnifying power of 70 and a field of 52′, with two crossed spider lines, dividing the field into four quadrants.

I had been assured by an inhabitant of Tortosa, about 25 miles N. of Vinaroz, that we were sure at this season to have cloudless skies. Unfortunately, this prophet of his own country was in error, or rather the weather was abnormal. Monday and Tuesday were cloudy in the afternoons, a presage of what we were to experience on the Wednesday. Tuesday was a choking day of hot south wind, a veritable sirocco, which in the afternoon grew violent, and raised clouds of dust. At evening we had a thunderstorm, but without rain. The weather-wise prophesied perfect weather for the next day. Wednesday began auspiciously; the sun shone, and the clouds were dissolved in the warm air, though overhead at a great height some were thickening.

First contact was observed at $11^h\ 54^m$. It had taken place a minute or two previously.

I watched several sun-spots as they passed under the black disc of the moon. They were observed with a prism and a green glass, but did not differ sensibly in colour.

Now began our anxieties. A cone of dust cloud was rising slowly from the S.W. At twenty minutes before totality our chance of an untroubled view did not seem great.

As I had to announce totality I paid great attention to Baily's Beads. This phenomenon differed considerably from that of 1900. As then, I noticed the abscission and subsequent disappearance of the terminal portion of the southern part of the crescent. Mr. Chambers has quoted, in his "Handbook of Astronomy," Halley's description of this in 1715. A second time there was a division, again at the south end, but less distinct. The crescent fined down very much. A little way from either end it became narrower than at the ends themselves. The Beads appeared almost lance-headed, slightly diffused on the edges. The running together of the Beads was much less pronounced than in 1900. There were two remaining, at a slight distance from each other; that to the south disappeared first.

I had been observing too closely during the last few minutes to pay attention to the clouds, and I had seen Baily's Beads so distinctly that I never thought there could be any. But I slipped off the green glass, and it was evident something was wrong. The black disc of the moon stood out forward. Behind there was a bright but diffused light, which seemed to come from behind the moon. But no coronal detail could be seen, nor in the telescope did I see any the whole time. However, I had no time to lose. The chief thing I intended to do was to map down the positions of the prominences, red, white, or pale tint, with coloured chalks. Five splendid prominences were glowing

brilliantly in the N.E. quadrant. I had grey writing paper with circles in pencil, divided into quadrants corresponding with the wires in the eye-piece. I got the position of the prominences approximately correct, but it was difficult at first to say of what colour they were. At first they seemed white, then I noticed a faint tinge of red, as of vermilion much diluted with Chinese white. When the chromosphere appeared it could not be said to be red. The atmospheric condition was answerable for this, and what I saw were the usual hydrogen prominences. None were in the least like the two shining white columns I saw at Ovar in 1900. All were somewhat plumy or cloudlike, or arboreal in form. One of the latter shape had a double trunk.

Long before these five prominences in the N.E. were covered by the moon's disc one appeared *floating* with no attachment, not more than 30°, if so much, from the N. Pole in the N.W. quadrant. Others gradually revealed themselves, till I had mapped 7, and in both quadrants 12. I saw none in the southern hemisphere. All were pale, but very brilliant. Those in the N.W. quadrant had perhaps a trifle more colour.

I found it useless to observe the corona with the telescope, so I had several good looks with the naked eye. Though there was a small thin cloud covering the sun, the corona was most brilliantly visible through it. It was not pearly or silvery white, nor was there any trace of colour. The moon was the blackest of blacks, the corona the intensest of whites, and very bright. The full moon at the meridian was not comparable with it, in tint or brilliancy. I thought of our Lord's garments at the Transfiguration, "Candida nimis velut nix."

The corona seemed about half a solar diameter broad. It was, of course, impossible to see any faint outlying parts. It appeared pretty equal in breadth all round, the edge bordered with aigrettes. For the last 10 seconds it was free from clouds, but I saw nothing to add to, or take from, what I have recorded.

I had to give the order to close cameras, so I watched carefully for the orange red glow of the chromosphere. I saw no decided colour, but the western limb suddenly became so bright that in some alarm I called out "Close"; and in one second the sunlight appeared. Totality had lasted $3^m\ 25^s$, as against the calculated $3^m\ 36^s$.

The sunlight regained its brilliancy with extraordinary rapidity, by bounds as it were, so that almost at once all impression of eclipse was gone. Before long one felt the sun beginning to scorch again in cloudless intervals, the temperature having been agreeably cool for some time before totality. The darkness may be estimated by the following. The grey notepaper on which I drew had a fairly dark circle in pencil, and cross lines about twice as broad and dark. The latter were clearly visible, but the former so little so that I found my red chalk marks were some within and some without the circle.

I heard from others that they had seen the undulating shadows. None of us had time to look for them.

There were no flowers, and very few birds to observe. The behaviour of the latter was distinctly abnormal, as they were terrified by the discharge of bombs by a well-meaning person, who

hoped thus to break or scatter the clouds. This is commonly done (or attempted) in the case of thunder-clouds which are low. But as these bombs are loaded to burst at from 400 to 500 metres, and the clouds were enormously higher, their effect, as might have been foreseen, was nil.

The houses, mostly flat-topped, were crowded with spectators, who applauded the eclipse so heartily that my signals and Father Cortie's counting of seconds were not too easily heard. As a spectacle, at least, the eclipse was highly appreciated by them.

By Mr. C. J. TABOR.

(At Roquetas.)

My wife and I intended to view the eclipse from Tortosa, a town 40 miles S.W. of Tarragona, the Astronomer Royal having kindly advised me that it was within the line of totality.

It was our intention to go somewhere outside the town for our view of the eclipse, but we learned that there was a fine observatory belonging to some Jesuit Fathers at Roquetas, about 1½ miles outside the town, and thither we made our way the day before the event.

On sending in our cards and saying I was a Member of the British Astronomical Association, Señor Ricardo Cirera, S.J., Director del Observatorio del Ebro, received us with the utmost courtesy, invited us to use the grounds of the observatory on the morrow, and offered to lend us any instruments we might require, provided they were not in use by the Fathers themselves. The Reverend Fathers established themselves in Tortosa many years ago, but only last year acquired these grounds at Roquetas, built an observatory on the high hill, and changed the grounds, which were then a waste, into a beautiful park; all this was done without any State aid. They have erected, and practically equipped, as perfect a physical laboratory as any body of scientists could wish to use, and the astronomical instruments in the observatory would do credit to any society.

The morning of the eclipse broke without a cloud, and we considered ourselves fortunate. Arrived in the grounds, we soon ascended to the hill of the observatory, and found a few native ladies and gentlemen there provided with smoked glasses, &c., whilst, a little higher up, the observatory terrace was fully occupied by the Reverend Fathers, each one told off to his own particular duty.

We had provided ourselves with two powerful field glasses, with a sun-cap on one ocular and a direct-vision spectroscope attached to the other. The sky was then absolutely cloudless and the heat intense, but one of our hosts told us they had received reports of "*todo malo tiempo*" from other stations.

We observed the first contact at $11^h\ 56^m$, Spanish time, and there were no signs of clouds. The progress of the shadow was very rapid, and half phase was reached without any clouds appearing. Up to then there was no perceptible loss of light or heat; but soon afterwards it became much colder, and clouds began to form, obscuring the sun. The light became dull, like

that which in this country precedes a thunderstorm, and we began to experience a peculiar shivering sensation, without being actually cold.

We had from the first carefully focussed our spectroscopes and constantly observed the absorption bands, which came out very clearly. Till within one minute of totality these bands were visible, when the now nearly obscured sun broke through the clouds, and we were hopeful of seeing the flash, but alas! at the moment before totality the sun was absolutely hidden from our view by a thick bank of cloud, and so we missed this interesting phenomenon, nor were we more fortunate at the end of the total phase.

True, we glimpsed the corona for a second or so at intervals, and once for half a minute the light from it seemed to be of a pearly whiteness, diffused, but the clouds were so dense all round the sun that we could not see any streamers. We noticed a large red prominence like the Greek capital letter Γ on the N.W. limb of the sun.

My wife saw it as an electric blue; this was probably due to fatigue of the optic nerve; for myself, I should call it a brilliant red. I regret I could not examine it spectroscopically, but I was endeavouring to secure a negative of the corona during the very short intervals in which it was possible. I had, unfortunately, gone out without a finder on my camera, and the result was that one image of the sun is quite at the edge of the plate, the second one is well centred, but both are too unsatisfactory to be of any service. As the shadow passed off, the clouds dispersed, and at last contact at 2.5 p.m. there was nothing to be seen but a brilliant sun and a blue sky. It has occurred to me that the possible cause of the clouds might be condensation—the sudden cooling of the moisture in the air as the body of the sun became obscured. Daylight returned very rapidly. I was interested in observing the amount of light at the time of totality, and could readily see the figures on the white face of my watch; the faces of the natives in the valley below and on lesser eminences than our own were clearly visible. I should estimate the light as that of twilight on a summer's night in England. The effect was certainly most weird. The cocks in the neighbourhood crowed persistently, but we saw none of the phenomena of flowers closing their petals or birds going to roost, as are mentioned by some observers of former eclipses. Immediately after totality Venus appeared very brilliant.

By Prof. MARCEL MOYE, D. en D.

(At Alcala de Chisvert.)

I observed this magnificent eclipse at Alcala de Chisvert, a little town on the east coast of Spain. I was favoured by the Spanish skies, as on the day before we had experienced chilly and wet weather. Hope was almost gone, but at night the clouds dispersed and stars were glittering everywhere. At sunrise, however, an ominous strip of clouds was visible in the south,

and all the morning we watched clouds on the horizon—a rather painful watch.

The first contact was seen in a perfectly clear sky, but some minutes afterwards clouds slowly made their way in front of the sun. I was again in despair, but at the eventful moment clouds had passed and totality displayed its beauties without interference, except at the end, when there was a light and transparent vapour, of which I shall say a word later.

In order to secure good observations my programme was very limited, and I had plenty of time to go through it without hurry. I intended to observe, (1) the shadow-bands, (2) the corona, (3) the general aspects of the eclipse.

In the eclipse of 1900, that I observed at Elche, I had a good view of these enigmatic shadow-bands, and I was eager to see them again. I saw them three minutes before, and three minutes after, totality, being unable to observe any during the total phase. They were like greyish ribbons, not black, tolerably distinct and very wavy. I noticed their direction was from S.W. to N.E., and they had perpendicular motion from N.W. to S.E. Both before and after totality a moderate wind was blowing from the S.W., and clouds drifted from W. or N.W.

On the white and smooth soil (the platform of the station) I had some rods with metric graduations. I estimated the width of the bands at two inches and their distance apart at three or four inches. The motion was slow, difficult to observe exactly, perhaps one or two inches per second. The shadow-bands reminded one of a rope tied at one end and made to wave with the hand to the other end.

In the observations of the corona I used only a good opera-glass. I sketched carefully the coronal streamers, and I had time enough to compare my drawing with the actual sun. The sun was encircled by a white silvery ring, very bright, almost dazzling on the limb, but fading away softly in the darkness of the sky. Around this inner corona was an intricate system of streamers, of a pearly hue, resembling an irregular star with six or seven points. Long rays were diverging from the solar poles, a complete contrast to the equatorial wings of the 1900 eclipse.

Even with the naked eye two groups of prominences were evident as magnificent rosy flames on the white corona. The brighter group was in the N.E. and the other in the S.W., almost diametrically opposite.

All coronal streamers were more or less of an ogival outline, as noticed in previous eclipses. Their bases were broad, and they were tapering, and melted away very gradually.

Three of the streamers are worthy of a special notice. The N.E. ray was hanging exactly over the beautiful prominence seen at its root. It seemed an extension or, better, a sequence of the solar eruption. However, the second group of prominences (on the S.W. limb) did not disturb, apparently, the coronal filaments. The N.W. streamer was one of the longest, perhaps one-and-a-half lunar diameters from the limb, or four radii from the centre. Curiously enough, its north boundary was very sharp, even on the lunar limb, and in the inner corona a dark rift was thus very conspicuous, even to the naked eye. The southern streamers

went so far as five lunar radii from the centre; there the corona displayed its greatest activity. These streamers were complex, apparently double, as if formed by two ogives overhanging.

On the whole the corona was decidedly brighter than it appeared in 1900. Its tolerably regular features, its stellar form, the polar activity, were just to be expected in a maximum year. At the first glance I was struck by the perfect likeness of the actual corona to the predicted drawing of the astronomical text-books.

The general appearance of the eclipse was, perhaps, less interesting than in 1900. At totality the brightness was surprisingly intense. I did not find any difficulty in making my sketch or in reading small letterpress. The features of the landscape, the details of a railway-engine, the divisions of a watch, all were seen very easily. The eclipse of 1900 is recorded as a bright one. For my part, I believe that of 1905 was yet brighter; a result, perhaps, arising from the greater activity of the solar envelopes. Owing to the general illumination, decidedly lighter than a full-moon night, I was unable to see any star or planet, with the exception only of Venus. The sky was grey, not dark, rather of a neutral tint, especially in the north, with a yellow fringe in the south. The clouds also were greyish, but without any abnormal appearance. On the landscape was the same greyish hue, without any suspicion of red.

The eclipse wind was very noticeable, coming to a standstill some minutes after totality. In the shade the fall of temperature was about 5° (Fahrenheit). In the higher atmosphere the fall must have been greater, for at totality a thin vaporous veil (alluded to before) made its appearance around the sun. It was not a cloud, having no movement, and not seen before or after totality, but rather a sudden condensation of the aqueous vapour by the coolness of the coming shadow.

By Mr. T. W. BACKHOUSE, F.R.A.S.

(Near Cistierna.)

Accompanied by Mr. Irwin Sharp, I observed the recent total solar eclipse from one of the summits of Peña Corada, near Cistierna, in the province of León, Spain. A higher summit lay a little distance to the north-east, and much further off were still higher mountains from thence to the west-north-west. When facing south-south west the view for half of the horizon was over the undulating table-land of León, the mountains of Galicia bounding the western horizon.

There was a good deal of cloud during the eclipse; still, the sun was visible most of the time, though frequently through the clouds, which were fracto-cumulus and more or less detached. But the middle of the eclipse was, unfortunately, the very cloudiest part of the day, except before 9 a.m., perhaps not even with that exception. The clouds seemed to be rapidly becoming denser and more continuous as totality approached. Their apparent density might, however, be partly due to the darkness

caused by the waning sunlight. The varying density of the clouds, and the irregularity of the gaps of sunlight on the landscape prevented anything like a definite shadow of the moon approaching before, or going away after totality being seen; only one could see it was very dark both on land and clouds for two or three minutes before and after totality in the direction of the shadow; indeed, I could not see the outline of the land in those directions.

When the sun was reduced to a crescent a very black cloud hid it; but about two seconds later it grew suddenly much darker, and I judged that totality commenced then, viz., at $1^h\ 3^m\ 38^s$. It was certainly not later than this, and may have been a second earlier.

The Greenwich times of the four contacts as observed by me are as follows, assuming that my watch was 10 seconds slow:—

	h	m	s
First contact	23	44	10
Commencement of totality	1	3	38
End of totality	1	7	23
Last contact	2	23	40

Mid-totality occurred, therefore, 20^s earlier than the calculated time.

The first and fourth contacts are necessarily rough, being observed only with field-glasses.

The apparent density of the clouds must have been partly owing to the moon's shadow, for I was much surprised to see the corona only 3^s or 4^s after totality began; it continued visible all the rest of the time of totality. But it was seen only through clouds till quite towards the end of the total phase, when I think it was quite clear, though I am not sure. It was conspicuously visible to the naked eye, but I observed it mostly through field-glasses, power 4. For half the time, or more, I could not see it to a distance of more than half the radius of the moon; but even then I could see that its structure was very complex. The rays, which were very numerous, seemed pretty equally distributed in all directions. This made it a very difficult object to draw; indeed, I did not attempt to draw it till after totality was over. Whenever the clouds grew thinner, I could see several of the rays to a considerable distance. They still seemed to have no particular system of arrangement, in which respect this eclipse was quite different from that of 1900. A drawing was made after totality was over; it shows only the longest rays; there were many shorter ones between them. I am pretty sure the ray to the right was not directed from the sun's centre. I estimated the longest as nearly twice the moon's diameter.

As to the prominences, there were no lofty ones; the most conspicuous one was deep red, and I have an impression that some were paler red. I cannot say whether there were any white ones. My chief attention was directed to the corona, which was pearly white, and very bright next to the moon. The prominences were much brighter than the brightest part of the corona.

As to the darkness caused by the eclipse, Mr. Sharp and I agree it was a good deal darker than the eclipses of 1898 and

1900. This would be partly owing to clouds, but I thought not entirely. I took one photograph and Mr. Sharp three; he found it impossible to see the numerals on the film without the aid of a lantern, but I could see the time by my watch quite well.

The French astronomers from Paris, Besançon, and Toulouse, who were at the foot of the mountain, unfortunately, saw nothing of the corona, owing to clouds. Though not above any clouds in the neighbourhood, we were above heavy showers of rain, which obscured the view in various directions, and may have obscured the eclipse where the French had installed their magnificent apparatus.

Before and after totality I took snapshots with No. 2 Kodak Bull's-eye camera of the view to south-south-west. Owing to the varying amount of cloud I do not think a conclusion could be arrived at as to any difference between the advancing and the retreating darkness. On the whole, there was less cloud after totality than before.

Mr. Sharp exposed a 5-in. by 4-in. Cartridge Kodak three times. I can see very little detail upon these photographs that one can be sure is genuine. The durations of exposure were approximately 40^s, 20^s, and 10^s respectively.

In the third photograph the sun appeared just before the camera was shut, and it is visible on the print as a black spot, its brilliancy having produced a reversal.

I also exposed a Stereo-Weno camera, the images with which are still smaller.

The G.M. times of the four contacts, as set down on the maps in "Memoria sobre el Eclipse Total de Sol de 1905," are as follows, assuming our station to be one mile south-west of the summit of Peña Corada, which is given as 1° 22′ west of Madrid, and north latitude 42° 49′ in "Coordenadas Geograficas de "Puntos Comprendidos en la Zona de la Totalidad del Eclipse "de Sol, 1905":—

	Predicted.			Observed.		
	h	m	s	h	m	s
First contact - -	23	43	57	23	44	10
Commencement of totality -	1	3	57	1	3	38
End of totality - - -	1	7	46	1	7	23
Last contact - - -	2	24	21	2	23	40
Duration - - - -		3	49		3	45

The "Connaissance des Temps" gives the maximum duration in 1905 as 3^m 51^s, but the British "Nautical Almanac" as 3^m $43{\cdot}8^s$.

By Mr. P. M. Ryves.

(At Soria.)

In choosing my station I aimed at two points: firstly, to avoid places to which many observers were going, and secondly to get as high as possible above the sea level. I actually stationed myself at Soria, after having failed to find a suitable place in the mountains immediately to the north, and here I had an elevation

of a little under 4,000 feet, with a splendid position on a hill overlooking the town and commanding an extensive view of the surrounding country.

The sky on the morning of the eclipse was cloudy, but it cleared just in time for the total phase, and the air was very pure.

On account of some mishaps I was obliged to alter my original plan, and to reconstruct apparatus at the last hour. I am sorry to say that in the confusion of the moment I failed to carry out my idea of graduated exposures, and I have no record of the length of exposure given to each plate, nor of the time at which each particular plate was exposed.

Further, most of the plates were fogged by exposure to light in the apparatus which I had been constructing up to within an hour of totality. Altogether 11 plates were exposed, nine during totality, two just after. These latter are worthless, and one of those taken during totality is spoiled by shake. Six others are more or less fogged and also (most of them) out of focus. The remaining two plates are fairly successful.

I had a good view of the prominences with the Davis telescope (and observed the second contact) both at the beginning and end of totality, but being single-handed I could not get through all the work in the time, and I was too late to expose my last two plates before the end of the total phase.

By Mr. G. F. CHAMBERS, F.R.A.S.

(On board the S.S. "Arcadia.")

Two days before the eclipse several of the Members of the Association and their immediate friends, reinforced by some of the ordinary passengers, who became astronomers for the nonce, assembled in the saloon and talked over what to do and what not to do on the critical day. I took the liberty of circulating amongst those assembled a series of 18 suggestions, which I thought would promote the cause of science by giving hints as to what should be looked for and what might be expected, and various precautions which it was expedient to take. My attempts to methodise the work undertaken were favourably received, and the outcome of it all was that the whole band of workers, about 20 in number, consented to group themselves so as in some measure to avoid overlapping and unnecessary duplication of work. The arrangements, thus voluntarily entered into, worked very well, and, considering the small numbers engaged and the absence of a full supply of instruments of precision, I think it may be said that very creditable results were obtained.

I had intended myself giving special attention to Baily's Beads, the Red Flames, and the general outline of the outer Corona. I was provided with a very good 2¼-in. refractor, mounted as an altazimuth on a tripod stand, such as I had used in Portugal in 1900, armed with a power of 20, and a solar diagonal eye-piece.

Through some mischance, of which I am unable to give a satisfactory explanation, I was unable to see Baily's Beads, either at the beginning or end of totality.

The Red Flames were very striking on both limbs of the moon, but it was only on those visible at the second contact that I was able to concentrate careful attention. One point which specially impressed itself upon me in connection with them was that they lacked the brilliant carmine colour which so specially struck me in Portugal in 1900. I should describe their hue as merely a deep pink.

The only other point which I wish to dwell upon is one which I rather fancy constitutes a novel feature so far as regards previous observations. I saw the dark limb of the moon as it was advancing over the sun before the second contact as very definitely not an even curve, but bunched out with one, and I almost think two very pronounced excrescences. These were in the Southern hemisphere, and Mr. S. A. Saunder, to whom I mentioned the matter, suggested that the projection which I had seen was due to the Dörfel Mountains.

The sky, up to nearly the time of totality, was sufficiently clear to make us anticipate a satisfactory condition of the sky during the critical period. But just at the time of totality haze began to gather, and during the second half of the totality seriously prejudiced our observations, without actually preventing them. I mention this matter thus in some detail because I think it furnishes a clue to the fact that the intensity of the general darkness fell very far short of what I understand to be usual, and certainly of what I witnessed in Portugal in 1900.

The only observation not made by myself which I purpose here to mention is that which was made by Mr. Bacon, the chief officer of the "Arcadia." I had suggested, half in joke, that if anybody would go up to the masthead, I thought he, or she, would have a good chance of seeing the eclipse shadow come on, pass over, and pass away. Mr. Bacon took up the idea, and had himself slung up in a basket to the top of the foremast. His energy was crowned with success, for he saw the eclipse shadow well before its arrival and after its departure—a combination which, I believe, is not very common.

One other matter, and I have done. I have said above that I provided myself with a telescope mounted on a tripod stand. For this I received no encouragement from my friends, most of whom jeered at the idea of the possibility of using on shipboard a telescope mounted on a rigid stand. I was not very sanguine myself, but when the time arrived I was able to use the telescope so mounted with perfect success. Thanks to the calmness of the sea, and the skill with which Captain Cubitt, R.N.R., handled his ship, my telescope was practically motionless throughout the eclipse, except as and when I found it necessary to give it a push in order to follow the moving sun. We all felt that we owed a great debt of gratitude to Captain Cubitt for the many facilities of various kinds that he gave us for the successful performance of our work. One of his officers noted a matter which I do not remember to have seen previously recorded. Not

only did he notice the breeze which almost or quite always accompanies the total phase of a total eclipse, but he observed that the wind shifted during its continuance through eight points of the compass.

By Mr. S. A. SAUNDER, M.A., F.R.A.S.

(On board the S.S. "Arcadia.")

The party with which I was associated observed from the top of the smoking saloon. By the kindness of Mr. Bacon, the chief-officer, half of the roof had been whitewashed in order that we might observe the shadow-bands.

Those present on the roof were Mr. F. W. Longbottom, Mr. J. H. White, Mr. Drake, one of the ship's officers, who was provided with a sextant, and myself. As I had intended to devote my attention principally to the extension of the corona, I kept my eyes covered during the earlier stages of the eclipse. Mr. Longbottom from time to time described the course of events, and when, just before totality, he told me that shadow-bands were visible, I removed my bandage and placed myself in the best position to see them. After a few seconds I saw them faintly, but distinctly, and estimated their breadth at half an inch, with about 3 inches between consecutive bands. Their motion was such that when I tried to follow one, I found that I suddenly lost it and picked up the one behind, as often happens when trying to follow a particular wave on the sea.

I then looked up at the sun and found that totality had commenced. I went back to my first position, took up my binoculars, which have 2 inches aperture and power about $3\frac{1}{2}$ diameters, and looked at the corona. I noted three prominences against the advancing edge of the moon, and watched whilst they were partially covered. By this time a layer of cirro-cumulus had spread over the sun, and I found that it would be impossible to observe faint extensions of the corona, but I estimated the longest streamers at about $1\frac{1}{2}$ diameters from the limb of the moon.

The inner corona appeared intensely brilliant, and this seemed to me to account for the fact that the colour of the prominences was of a rosy hue rather than an intense ruby, as I had anticipated.

I then examined the corona with a two-prism McClean's star spectroscope, with spherical lens and no slit. This was attached to the end of a small telescope of $1\frac{1}{2}$-in. aperture and $14\frac{1}{2}$-in. focal length. I was disappointed to find a brilliant continuous spectrum instead of an image of the corona in the green coronal band. I then examined the corona with a small Browning pocket direct vision spectroscope, and again was unable to detect bright lines against the continuous spectrum. I did not notice the Fraunhofer lines, but this may have been due to the width of the slit.

I certainly saw the corona after the conclusion of totality, but as the time signals had not prepared me for the end, I am unable to say for how long.

After this disappeared I endeavoured to see the outline of that part of the moon beyond the disc of the sun, but felt from the first that this would be impossible in consequence of the cloudy state of the sky.

My impression was that the corona was intensely brilliant, and not much extended. The eclipse seemed a very light one, and there would at no time have been any difficulty in reading ordinary print or in taking the time from a watch. I was provided with a bull's-eye lantern, but had no necessity for using it.

I should infer from its spectrum that the corona must have contained a large amount of solid matter.

After the eclipse I laid down a rod in what I imagined to have been the direction of the length of the shadow-bands and found this to be 6° N. of W.

The times of the several contacts as observed by Captain A. G. Cubitt, R.N.R., with a small telescope and the ship's chronometers were:—

	h	m	s
First contact - - -	23	57	16
Second ,, - - -	1	16	16
Third ,, - - - -	1	19	55
Fourth ,, - - -	2	36	33

Captain Cubitt told me that he thought this last time was probably 3^s or 4^s too late.

The ship's position at first contact was:—

Lat. 39° 47′ N. Long. 0° 39′ E.

At fourth contact it was:—

Lat. 39° 49′ N. Long. 0° 33′ E.

As the motion was nearly uniform the position during totality must have been nearly:—

Lat. 39° 48′ N. Long. 0° 36′ E.

In conclusion I should like to express my sense of the debt we owe to the ship's officers, and especially to the captain and chief officer, for the kindness and care with which they made every possible arrangement for facilitating observation.

By Mrs. Arthur Brook.

(On board the S.S. "Arcadia.")

As a spectacle the total eclipse of 1905 was not as striking as that of 1900.

As seen from the P. and O. S.S. "Arcadia" off the Columbretes Islands, the 1905 eclipse during totality was much brighter than that seen at Algiers in 1900. In the total phase of 1905 it was quite easy to read the time by a lady's watch, whereas in 1900 this could not have been done.

Venus was picked up by me as a white point at $1^h\ 3^m$; if it had not been cloudy, I think it would have been seen earlier. I looked during totality with binoculars magnifying eight times for stars, but saw none, nor did I see the planet Mercury. Venus

became very yellow and bright during totality. The view of the corona during part of totality was not perfectly clear owing to cirrus clouds. The inner corona was very bright and dazzling, and by its brilliancy deprived the outer corona of the pearl-like appearance which it had in 1900. I searched round the outer and inner corona with glasses during the first $2\frac{1}{4}$ minutes of totality for dark rifts, but could not see any. The corona was very evenly distributed round the moon's disc for about one diameter. I noticed that there were no long streamers corresponding to the large set of red prominences which appeared on

THE CORONA, AUGUST 30, 1905.

Composite drawing by the Rev. T. E. R. Phillips from sketches by observers on board the S.S. "Arcadia."

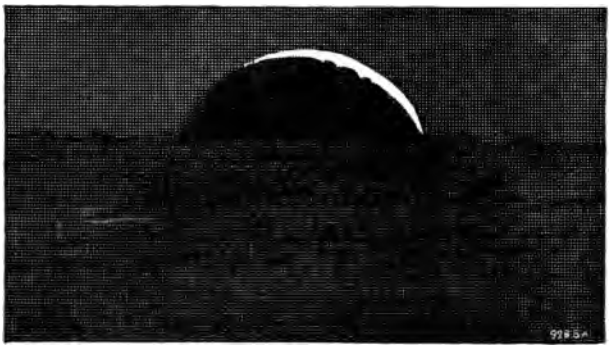
the N.E. The longer rays towards the vertex seemed to be rather more to the N. than the prominences. The coronal rays were in no case in curved lines; all seemed to be projected in straight lines prolonged from the sun's centre to its circumference. The longest rays of the corona, as seen with the binoculars, were about $1\frac{3}{4}$ to 2 diameters of the moon, and by the naked eye about 1 diameter. There were four longer rays, one on each side of the vertex, and one on each side of the opposite pole. That to the S.E. seemed the longest of the four; that to the S.W. the next in length.

The red prominences seen on the E. side of the vertex at the beginning of totality in 1905 were much larger than those seen in 1900. A group formed of four or five close together, but distinct from one another, was very fine. Any one of these five was as long as the longest prominence seen in 1900, but of these only one (that nearest the vertex) seemed to thicken at its outer end and turn downward; which form I particularly noticed in the large prominence of 1900. In colour those of 1905 were a pale pink, or they might be better described as of a faint, transparent ruby colour over white; not nearly as bright or as solid looking as those seen in 1900. The prominence on the S.W. side seen at the end of totality was visible for only about 3 seconds before the bright spot of returning sunlight ended totality. This alone was of the brilliant ruby colour equal to those of 1900.

By Mr. RICHARD N. LEA.

(At Manitou, Manitoba.)

I enclose a sketch made from the top of "Star Mound," Manitoba, on the morning of August 30th, showing the appearance of the eclipse after totality, which I trust may be of interest.



Our atmosphere being so intensely clear, I had a good opportunity of witnessing the phenomenon.

The passing of the moon's shadow was a wonderful sight, one never to be forgotten; the colour on the prairie, in shadow, being a rich, deep purple.

By Mr. H. B. ADAMES, F.R.A.S.

(At Whytewold, Winnipeg.)

I had hoped that it would have been my good fortune to submit to the Association some interesting notes on the recent total solar eclipse, as the spot that I had chosen lay some 20 miles north of the central line of the moon's shadow, and practically

at the beginning of the eclipse path, the sun rising totally eclipsed. But, unfortunately, weather conditions prevented my doing so. Perhaps, however, an account of the few phenomena witnessed may be serviceable.

Accompanied by several friends I proceeded to Whytewold, a village situated on Lake Winnipeg, in Long. about 96° 58′ and Lat. about 50° 20′ N., in the evening of the 29th. Clouds had already begun to gather, and it was evident that the chances of a good view would be small. However, shortly after 11 o'clock a large clearing, which persisted, more or less, until 4 a.m., appeared

in the zenith, and gradually spread halfway to the horizon. It was not many minutes after this that there appeared one of the finest displays of the Aurora Borealis that have taken place this year. The whole of the northern heavens as far as the zenith, and even south of that point, became a quivering mass of wavy green streamers, whose eastern edges developed an intense violet hue. About 5 a.m. Venus, which had appeared particularly bright until that time, gradually became obliterated by light hazy clouds, which rapidly increased until the whole sky became entirely covered by heavy threatening nimbus clouds. My observations were as follows:—

h	m	s	
5	15	0	Light appreciably diminishing in intensity.
5	30	0	An orange band of light low down in the east showed that the clouds were decreasing at the rising point of the sun.
5	40	30	Evidently the umbra of the shadow covers us, for hardly can I read my watch.
5	41	15	I had been intently watching with a pair of field-glasses the point where I knew the sun would rise, when suddenly there shot into the field of view a large white flame, almost immediately over the north pole of the sun, at once followed by a portion of what I suppose must have been the limb of the moon. Owing to a thin film of cloud, this had a reddish appearance, but the flame was unmistakeably white.
5	41	45	With startling suddenness the entire body of the moon appeared, still veiled by light cloud. On either side a blood-red prominence was visible. The huge black ball, immensely exaggerated

by proximity to the horizon, surrounded by a blood-red ring (except at the extreme north and south points, where clouds obstructed the view), appeared to be resting on the waters of the lake. Shortly after this, as though a great black mantle had been removed, the shadow passed.

Being placed in the unique position of the beginning of the shadow track, the two observations may possibly be of some interest. The central line of the shadow lay through Selkirk, a town 20 miles to the north of Winnipeg and an equal distance south of Whytewold, at which two places, from calculations by Prof. Upton, the total phase lasted 98 seconds. The time used is central standard time, meridian of Fort William.

I omitted to mention one very pronounced feature of my second observation, namely that the dark body of the moon, instead of presenting, as is usual, the appearance of a plane surface, very forcibly showed the fact of its being a spherical body.

As to observations obtained by others, a few notes may be of some interest. At St. John's College, Winnipeg, the advance of the shadow is described as follows. Between $5^h\ 40^m$ and $5^h\ 40^m\ 30^s$ a very appreciable twilight was manifest; this increased suddenly until it reached a very deep twilight, which continued for a number of seconds. Then another sudden darkness came on, and the twilight increased again to a very considerable degree until the maximum darkness was reached. This seeming jerkiness of the movement of the shadow and approach of darkness was one of the most startling and peculiar phases of the eclipse. Another was the splendid band of shadow which stretched from the eastern to the western horizon at the time of totality and divided the red glow on either side. Precisely at $5^h\ 42^m$ the darkness began to decrease, but without the jerky movement which had characterised its increase, until in a few seconds light returned and all was over.

The Approach of the Moon's Shadow.

By Mr. C. G. J. Dolmage, M.A., LL.D., D.C.L., F.R.A.S.

I posted myself high up on the Old Castle Hill, which rises behind the town of Burgos. I had chosen this spot, because it commanded an uninterrupted view towards the west; and I was desirous, if possible, to note the approach of the great shadow.

Just before totality, when the western sky had darkened to the semblance of the blackest of coming storms, there still stretched before me several miles of dimly sunlit ground, across which each instant I expected to see the boundary line of the shadow swoop in my direction.

On the contrary, however—as if some mighty candle were dying out—several huge flickers passed in rapid succession across the still illuminated ground, and at right angles to my line of sight. Then, suddenly, and without further warning, I found myself engulphed in the totality.

The darkness of the total phase was very much less than I had expected. There was enough diffused light to enable me to draw on white paper, and at the same time to see easily what I was setting down.

Spectroscopic Observations.

By the Rev. T. E. R. PHILLIPS, M.A., F.R.A.S.

(At Burgos.)

Spectroscopic observations were made by Mr. T. Thorp, Mr. E. Dickson, and myself. Mr. Dickson and myself also obtained photographs of the chromospheric and flash spectrum just before totality.

The visual observations were all made by means of gratings by Mr. Thorp placed in front of one of the object glasses of our binoculars. With apparatus of this kind the reversal of the dark lines is quite a gradual process, since the spectrum of the whole uneclipsed limb is visible at once. The reversal commences at the cusps and then follows the diminishing arc of light up to the point of second contact.

Mr. Thorp sends the following note:—"I could early "distinguish the bright lines in the horns using the objective "grating, and at the moment of totality the whole, or what "appeared to be the whole, of the lines reversed. Several "prominences made their vivid appearance, principally in the "hydrogen lines, and notably a very extensive one with a deep "depression in the left upper quadrant. Being irregular in shape "it may have been made up of several. During totality I care-"fully looked for and observed the green coronium line. It was "comparatively vivid and extended all round the sun's limb. "It was, however, very uneven in breadth (the broadest portion, "about $\frac{1}{10}$ the solar diameter, lying in the left hand bottom "quadrant at about mid-totality), and had very little, if any, "connection with the prominences—at least that was my "impression."

Mr. Dickson secured a remarkably fine photograph of the flash spectrum by means of a Thorp grating placed in front of the lens of one of his cameras. My own photograph was taken with similar apparatus to that employed by Mr. Dickson, but a moment or two later, just as Baily's Beads were disappearing. Unfortunately, the lines are not very sharp, but about 60 come out on the negative. A short discussion of this plate is given in my full report of the photographic results. There seems to have been a number of very lofty calcium prominences, as Mr. Dickson's plate and my own show. The images of three and two respectively are on the H and K lines beyond the N. cusp, and two each beyond the S. cusp. It seems remarkable that no trace of these prominences appears on the lines of hydrogen or any other element.

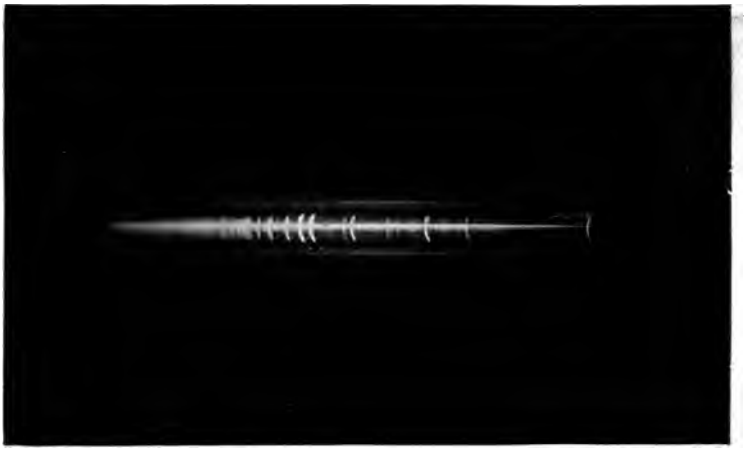
It is also perhaps worthy of mention that, although the green coronium line (W.L. 5303) was fairly conspicuous visually, there is no trace of it on my plate.

The Flash Spectrum.

By Mr. E. Dickson, F.G.S.

(At Burgos.)

The photograph (which is enlarged from the original about twice) of the flash spectrum was taken at Burgos on a Schleussner's Observatory plate, with a fixed half-plate camera, 15-ins. focus, single achromatic Wray lantern lens, working at f 22. In front of the camera lens was fitted a wooden frame, on the inside of which grooves were cut for the insertion of a Thorp grating, which was held in position as near as possible to the camera lens by two small brass clips. I used a binocular fitted with a Thorp grating, and arranged with my son, who had charge of the camera, to expose the plate at a given signal from me for as nearly as



The Flash Spectrum.
From a photograph by Mr. E. Dickson, F.G.S.

possible 1¾ seconds. The lowest strong line in the illustration is the Hβ line, and to the left of the strong lines H and K in the middle of the plate are numerous lines of H, ranging from Hρ to Hξ. A line of titanium is seen between Hι and Hκ, and three lines of titanium occur at the extreme left. It will be noticed that the spectrum lines are especially well defined in the ultra violet. In addition to the lines of hydrogen and titanium there are numerous lines of iron with lines of calcium, helium, and chromium, the hydrogen, helium, and calcium lines showing signs of prominences.

Meteorological Observations.

By Mr. A. C. D. Crommelin, B.A., F.R.A.S.

(At Palma.)

The following observations of temperature during the eclipse were made with a thermometer lent from the Royal Observatory, Greenwich, which was placed in the shade on the roof of the Grand Hotel. The time is Greenwich mean time, the temperature in degrees Fahrenheit:—

Time.	Temp.	Time.	Temp.	Time.	Temp.
h m	°	h m	°	h m	°
23 50	81·0	1 2	81·1	2 3	78·6
0 19	83·8	1 8	80·1	2 10	78·8
0 23	83·3	1 11	79·5	2 25	81·0
0 33	82·0	1 17	78·8	2 42	81·6
0 43	82·3	1 19	78·5	2 55	80·8
0 48	82·3	1 32	77·1	3 9	82·3
0 58	81·7	1 51	77·5		

The early morning had been entirely overcast, with some rain, and the sun did not break through till about the time when the thermometer readings began. The rise in temperature at the beginning is due to the improvement in the weather. The effect of the eclipse on the temperature was not noticeable till more than three-quarters of an hour after the first contact, when a rapid decline set in, and at totality it was nearly 7° below the previous maximum, and probably still further below the reading that would have been reached if there had been no eclipse. Barometer readings were also taken by Mr. Cayley, but as they show no decided effect of the eclipse they are not printed.

By Mr. T. W. Backhouse, F.R.A.S.

(Near Cistierna.)

I did not observe the thermometer before the eclipse, but I do not think there was much fall of temperature. The readings were as follows:—

h	m	°	h	m	°
0	58	47	1	16	46
1	40	46	2	35	49

It would probably be a little above 49° before the eclipse began, though it may not have been any higher than after the eclipse; indeed, it was quite possible that 49° was the maximum for the day.

By Mr. H. B. ADAMES, F.R.A.S.

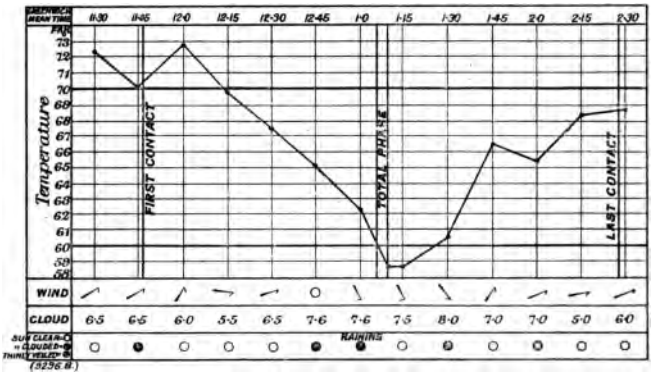
(At Whytewold, Winnipeg.)

The following were the readings of the thermometer for each $\frac{1}{8}$ of an hour:—44°·1; 44°·0; 43°·2; 43°·0; 42°·9; 43°·0; 44°·0. The barometer stood at $5^h\ 30^m$ at 29·358 ins., at $6^h\ 30^m$ at 29·405 ins. The aerometer showed that the wind dropped from 12·5 miles per hour at $5^h\ 30^m$ to 11·2 miles per hour at $5^h\ 45^m$, and its direction changed slightly more to the westward.

Charts illustrating the Meteorological Conditions during Totality.

(1) By the Rev. T. E. R. PHILLIPS, M.A., F.R.A.S.

(At Burgos.)



---

(2) By Mr. JOHN H. WILLIS.

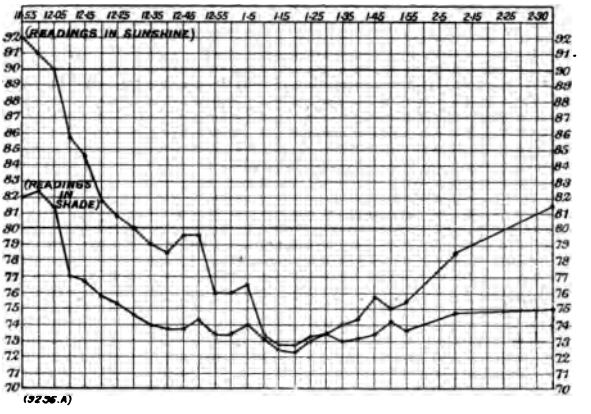
(On board the S.S. "Arcadia.")

Temperature.—The fall of temperature during the eclipse was somewhat irregular, owing to the varying conditions of the weather; the total fall of the exposed thermometer was from 92°·0 to 72°·8, and the fall of the shade thermometer was from 82°·4 to 72°·3.

Cloud.—At first contact the sky was cloudy, save for a large patch of clear sky overhead, which gradually widened, till at $1^h\ 0^m$ there remained only a narrow belt of cloud on the horizon. Soon afterwards a large fan of cirrus cloud was seen advancing against the wind, and this, unfortunately, had reached and covered the sun at totality. It was, however, never dense enough to completely obscure the sun's disc, and, being somewhat broken, afforded frequent fairly clear views of the corona.

Wind.—The velocity of the wind, at an estimation, varied from about 6 to perhaps 12 miles an hour. At $1^h\ 24^m$, shortly

CHART OF TEMPERATURES DURING ECLIPSE.



after totality, a sudden breeze sprang up and lasted for some little while. There was also a similar rise of wind at $1^h\ 0^m$, which lasted for a couple of minutes only.

Photographic Results.

By the Rev. T. E. R. Phillips, M.A., F.R.A.S.

(At Burgos.)

The instrument employed in taking the photographs was a portrait lens of about 14 inches focus. Unfortunately, on trial it was found impracticable to dispense with one portion of the lens in consequence of the uncorrected spherical aberration, but the two portions in combination (the aperture being reduced to about $1\frac{1}{3}$ inches) gave a beautifully sharp image near the centre of the plate.

As the scale of the photographs is so small, the plates are scarcely suitable for reproduction; but a composite drawing of the corona showing the details apparent on the negatives is reproduced.

(1) *The Flash Spectrum.*

For this plate a Thorp grating with 14,540 lines to the inch was placed in front of the lens. The exposure was made first as Baily's Beads were disappearing, and it was prolonged after totality was complete. The camera had previously been focussed on the sun's limb so as to give as good results as possible for the corona. No special adjustment was made for photographing the spectrum, and, unfortunately, the lines, especially those high up in the ultra violet, are not as sharply defined as could be wished.

In all about 60 lines (some of them seen only where they cross the narrow strip of continuous spectrum produced by the last of Baily's Beads) can be distinguished on the negative, but there are regions in the ultra violet where the lines are too closely crowded and too ill-defined to be separately seen or measured.

In considering this plate I have taken a certain number of prominent lines, of which the identifications are practically certain, as fiducial, and measured the approximate positions of the rest from these. The work of identification has been greatly facilitated by comparing the negative with the plates and measures published in the reports on the Indian Eclipse of 1898 by Sir Norman Lockyer and Mr. Evershed in the Memoirs of the Royal Astronomical Society.

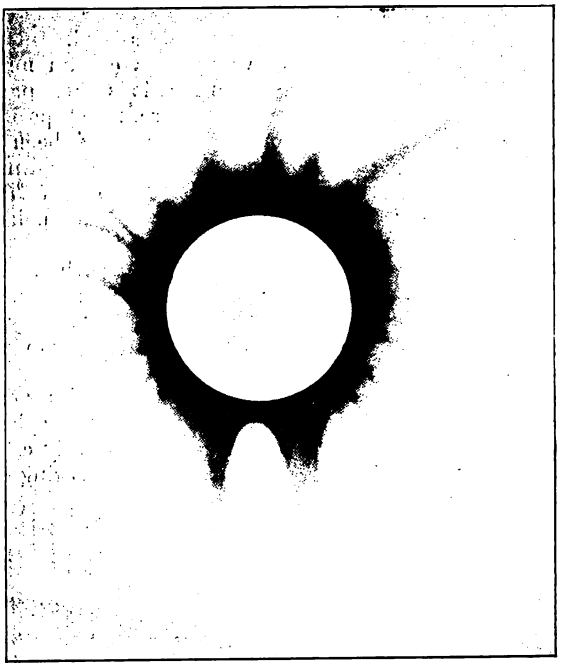
Not many lines come out in the lower spectrum. The D_3 line of helium (W.L. 5876) can be clearly traced on the negative; but, though the green coronium line (W.L. 5303) was very evident visually, it does not appear on the plate. In the ultra violet the spectrum extends as far as W.L. 3350.

On the whole it seems that the majority of the lines of which I have secured impressions belong to the chromosphere and prominences, but those with small arcs are probably caused by vapours in the "reversing layer" proper. The following elements are apparently represented on the plate :—

Elements.	No. of Lines on Negative.	Remarks.
Calcium	3	The H and K lines are the broadest and strongest on the negative.
Chromium	5	
Helium	4	
Hydrogen	12	Hε, which cannot be separately distinguished from the H calcium line, is not included. The hydrogen series is not traced beyond Hξ.
Iron	14	Several of these are "enhanced" lines.
Manganese	2	
Magnesium	1	Green line at W.L. 5184.
Strontium	2	
Titanium	16	Almost all are "enhanced" lines.
Vitrium	1	The identification of this line with that at W.L. 4178 is somewhat doubtful.

(2) *The Corona.*

It was a typical spot maximum corona. No very long streamers were seen or photographed, but the separate rays were fairly numerous. The most prominent feature of the corona was a very obvious vacuity or rift at about P.A. $\pm$ 190° between two conspicuous streamers. The inner portion of this rift approached rather near the moon's limb, and on the negatives a faint narrow ray is observed between the two streamers. Double diverging rays are seen at P.A. $\pm$ 85° and $\pm$ 105°, and one whose base is



THE CORONA, AUGUST 30, 1905.

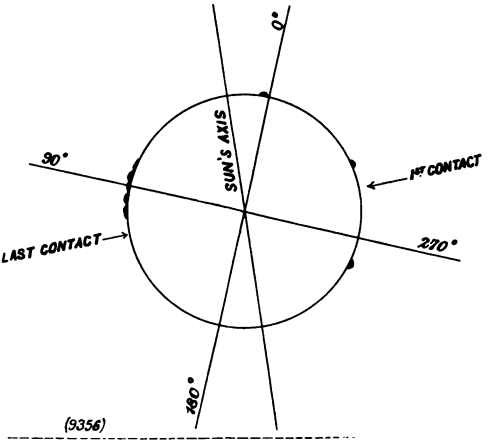
Composite drawing by the Rev. T. E. R. Phillips from photographs taken by himself.

at P.A. $\pm$ 350° is found on one of the negatives to extend for about 1½ diameters of the moon's disc.

The photographs show that very few of the streamers were truly radial. Those at the N. and N.E. limb seem bent in a common clockwise direction. The corona was slightly more extended towards the N.W. than elsewhere, so that the dark body of the moon seems to occupy a somewhat eccentric position.

(3) *The Prominences.*

There was a very conspicuous row of prominences at the east limb of the sun extending from P.A. $\pm$ 76° to P.A. $\pm$ 105°, which on the earlier plates have produced considerable indentations of the moon's disc. Their images are well shown on the lines of hydrogen, calcium, helium, and the "enhanced" titanium lines at W.L. 3759 and 3685 in the photograph of the flash spectrum. On the same plate the H and K calcium lines exhibit the images of four which project beyond the arcs over which the other lines can be traced. Indentations of the moon's limb due to prominences are also shown on the corona plates at P.A. $\pm$ 2°, $\pm$ 257°, and $\pm$ 307°. All the angles are reckoned from the north point through east, &c.



Direction of the Shadow and Positions of the Prominences.

It is somewhat remarkable that the prominence at P.A. $\pm$ 2° should have been bright enough to cause a deformation of the moon's limb on the two plates exposed near the beginning of totality, but should be invisible on those taken after "half time," when it must have been more uncovered and therefore might have been expected to exhibit increased intensity. Probably the prominence was of considerable elevation, and much brighter near its summit than at its base.

Sketch of the Corona.

By Mr. H. KEATLEY MOORE, B.A., B.Mus.

(At Burgos.)

Mrs. H. K. Moore, Miss Woolston, Miss Mary Proctor (daughter of the well-known astronomer), Captain Carpenter, and myself, sketched quadrants, and a combined sketch was made by me, with the assistance of all five, before leaving the ground. An eastward prominence was put in, but the size is much exaggerated—it was only intended to mark the position. It is seen to be, roughly, at the root of great streamers.

THE CORONA, AUGUST 30, 1905.

Composite drawing by Mr. H. Keatley Moore and party.

The body of the moon seemed to most of us to be of the same colour as the sky, but Capt. Carpenter and some others thought it was of a deeper tint. This may possibly be due to the influence of the bright corona.

Shadow-Bands.

These were well observed, horizontally by several groups of observers, on sheets stretched on the ground; and also by one observer vertically on the wall of a house. Mr. H. K. Moore observed them on a sheet throughout both before and after totality, and Capt. Carpenter observed with him for part of the time. Mr. Thwaites, Mr. Skinner, Mr. Leetham Jones, Mr. Bruford, Mr. McClean and Rev. T. E. R. Phillips also observed them successfully. The results of these observations may be summarised as follows.

The bands began to be visible very faintly, on account of the amount of general sunlight, at $4^m\ 36\frac{1}{2}^s$ before totality, and quickly reached their maximum strength as the general light declined. They never became strong at any time. The direction and pace were uniform till within 10 seconds of totality, when they moved more slowly, became broader, and lay wider apart than before. They ceased to be visible 5 seconds before totality, but whether this was because the light was no longer sufficient to see them by or because they had really ceased, it was not possible to determine.

As for their commencement, so for their cessation, no precise moment could be fixed.

During totality Capt. Carpenter watched the sheet, but could see no shadow-bands.

After totality the bands began to be visible again in 2 seconds, and it may be presumed that the shorter interval as compared with their cessation before totality was due to the greater sensitiveness of the eye which was rested by the comparative darkness. They began rather more slowly, and were wider and further apart than during their normal appearance, but this they almost at once attained, and then presented the same phenomena in every respect as before totality. They continued visible till $3^m\ 59^s$ after totality, the shorter time of visibility possibly again being due to the eye being blinded by the brilliancy of the quickly returning light.

The shadow-bands moved from W.N.W. (true) to E.S.E. (true) and lay normally to their motion, that is, they lay along lines from S.S.W. to N.N.E. The wind before totality was W.N.W. at the time the shadow-bands began to be visible, and after totality was N.E. at the time they ceased to be visible. It shifted very much.

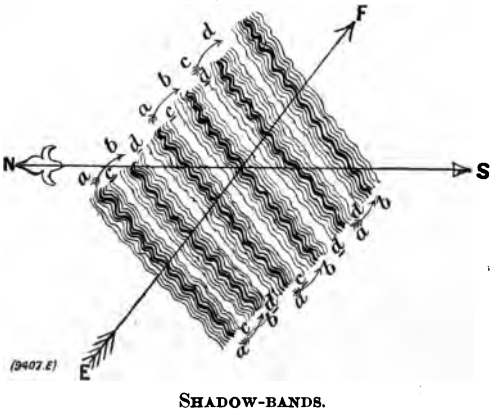
The bands were about $1\frac{1}{2}$ inches wide, of which the central inch was darker than the rest, and about 3 inches apart. They shimmered or flickered across the sheet faster than a man could walk (by observation), say at least $4\frac{1}{2}$ miles per hour. They were parallel, uniform in appearance, and not in groups, but they seemed to wave or flicker in the direction of their length, and at no time presented a definite continuous edge. One observer describes them as made up of connected blotches, another compares them to split waving rods, and yet another to the shadow of drifting rain. Perhaps they may best be likened to the reflections of ripples from a sunlit water surface on to an adjoining vertical surface, or to the shadow of the air-waves produced by a column of air passing over a heated surface, thrown upon a screen by a bright light.

The Rev. T. E. R. Phillips, who had not had time to observe the bands before totality saw them beautifully after totality on the tent close by, but only for a few seconds. They seemed to him to be rather narrow lines, parallel to the edge of the shadow, about 6 inches or so apart, and to be moving from west to east with an approximate velocity of about 5 or 6 miles an hour The general effect was that of a quivering, rippling motion over the white surface of the tent, but the bands were decidedly darker and more distinct than Mr. Phillips had expected them to be.

Mr. Crommelin states that shadow-bands were observed by Prof. Leahy and Messrs. Cayley and Churchill, white sheets being spread on both vertical and horizontal planes. The bands were distinctly seen before totality.

Three minutes before totality they were going in a direction 22° west of south. A minute later they had swung round and were only 17° west of south. This rotatory movement has been noticed before, but it was fully verified on this occasion.

Mr. John H. Gear made a successful observation of the shadow-bands upon a vertical surface, the wall of a house kindly lent for the purpose to the members of the expedition by the Spanish observers. This house faced S. 16° E. (true), which gave a wall plane running from W. 16° S. to E. 16° N., or only $1\frac{1}{2}$ points of the compass from true west and east. Mr. Gear found the bands moving *en échelon* up the wall, slanting 22° forward from the vertical, and rising (*en échelon*) 35° from the horizontal, as they advanced eastward. They seemed to him of double width and double distance as compared with the horizontal observations, *i.e.*, about 3 inches wide and 3 inches apart. He attempted to photograph them, but they were too faint. Mr. Gear considered the bands to be rather stronger after totality than before, and this opinion is shared by Capt. Carpenter. Otherwise his remaining observations conform with the rest.



SHADOW-BANDS.

By the Rev. J. T. W. Claridge.

The Rev. J. T. W. Claridge, M.A., F.R.A.S., saw no signs of the bands before totality or during totality. He says:—

" Immediately after the sunlight appeared, and as far as I could

" estimate for about 4 minutes, or nearly so, they were most " distinctly seen, not only on the white cloth but on the ground " itself. At first I was struck with their apparent dulness or " thinness, but this gradually ripened into a more pronounced " condition of light and shade till, towards their disappearance, " they seemed gradually to fade, so that it was well-nigh im- " possible to say for certain when the last band quitted the sheet. " The rate of motion was without doubt of a uniform character; " I consider that they travelled at the rate of some 8 or 10 miles " an hour. Judging from careful eye observations it seemed to " me that the average width of one dark band from another, say " from *a* to *b* in the diagram, or from one lighter space to its " successor, would be about 4 inches; this width seemed to be " very uniform and without variation, while the distance between " the bands would be not more than half an inch at the outside, " and also very regular.

" The drawing of the shadow-bands is a copy of the one " I made at Burgos immediately after the eclipse. The line " marked N.S. = North and South. Across the white sheet on " the ground a rod was laid in the position EF for the purpose " of showing the direction in which the bands moved. This, " it will be noticed, was from N.W. to S.E. by E. The rod " was left on the sheet for some few minutes after totality in " order that its true compass position might be ascertained.

" The letters *a* and *b* signify the thickest portion of each band, " and *c* and *d* the lighter or less bright interval between. I " have used the *a* and *b* mark to point out the distance between " the densest part of each band. It appeared to me (and " I watched them very closely) that each band was denser in " the centre *a* and *b*, which I have shown by the thick line, and " gradually faded, leaving a short and almost bright space " between. These latter separate intervals I have denoted by " *c* and *d*, and were of a regular and uniform character. The " mark from *c* to *d* also shows their width.

" I may be perhaps a little more explicit in comparing each " band to a wave, the highest part of which corresponds to the " dark line *a* or *b*, while the thinner lines indicate the lighter " parts of the bands, as *c* or *d*, as the wave gradually falls.

" The whole phenomenon was most striking and it certainly " would be very interesting to me to see other sketches and to " compare my notes with those of others. The subject is one " well worthy of study."

Mr. J. H. Willis, on board the s.s. " Arcadia," found the bands so conspicuous as to force themselves on his attention. They appeared occasionally to vary in intensity and speed, and on three occasions he noticed that they were crossed by similar shadows moving in the opposite direction. The wind and clouds were moving in opposite directions, approximately at right angles to the direction of the bands.

Mrs. Arthur Brook, who was also on board the s.s. " Arcadia," says:—" I watched about 10 minutes before totality for " shadow-bands, but saw none till three minutes before totality; " then faint lines appeared on the white sheet. Two or three

" seconds before totality these darkened, but there was no appear-
" ance of very dark patches or violent agitation, as seen by me
" and described in 1900. Though I did not observe the sheet
" specially during totality, I feel sure no such dark moving
" patches as in 1900 could have been present this year, as my
" cousin at first, and I later, should have found them inconvenient
" when drawing with white chalk on a dark paper during totality.

" As far as the eye could estimate such irregular lines, they
" seemed to me to be about 4 to 8 inches long and ½ to 1 inch
" broad, and about 4 to 6 inches apart. My son, A. C. Brook,
" estimated them independently as 'about 1½ inches in breadth,
" 'and a space of 2½ inches between each.' The direction of the
" lines themselves was from about 19° N. of E. to 19° S of W.,
" and they followed one another on the sheet at right angles to
" this; but there was also another movement, quite distinct (as
" it appeared to me) from this, for, as in 1900, the whole set of
" moving lines was also moving, as it were, off the sheet to a
" point about 15° N. of W."

Miss C. O. Stevens, at Càs Catalá, about 4 miles S.W. of Palma, made a series of observations for the purpose of associating the phenomenon of shadow-bands with the local movements of drift of the atmosphere. With a projected telescopic image of the sun observations were secured as early as 10.30 a.m., and continued at intervals up to within a few minutes of totality. The interest in these observations lies in the fact that the earlier ones showed the existence of two distinct strata of clouds moving at approximately right angles to each other, while, later, the upper of these two strata alone prevailed. The shadow-bands observed at Càs Catalá followed the course of the last-mentioned stratum of drift, and were in parallel formation, clearly delineated, while those at Palma were confused, and were found, in the first instance, to take the direction of the drift of cloud that had complicated Miss Stevens's earlier observations at Càs Catalá. The observation of meteorological phenomena by projection of the sun's image before and during eclipse constitutes a novel and, perhaps, an indispensable method of attacking the problem of shadow-bands.

[Other accounts of the shadow-bands will be found in some of the preceding reports.—ED.]

Colours and Atmospheric Effects.

Capt. Carpenter writes :—" The 30th August broke clear and " fine, but as the morning advanced the clouds increased. They " were of the high cumulus type, somewhat ragged at the edges, " and at 1 p.m. covered over seven-tenths of the sky. The atmo- " sphere at the observing camp, 2,800 feet above the sea, was " very clear, and details of scenery were easily visible at 15 miles. " As an instance of this clearness, I may mention that both the " crescent moon and the planet Venus were visible to the naked " eye at mid-day three days before. At the time of first contact " the colour of the landscape was grey with tinges of brick- " red where the red sandstone cropped up. A mountain range " distant some 25 miles to the E. was a pure blue.

" When more than half the sun was obscured the grey of the " landscape changed slowly to purple, and as totality approached " the clouds became darker at their centres with golden edges. " Far away to the N.W. by W., four minutes before totality, " I saw a darkening, such as one sees at sea of a coming rain " squall on the horizon, and when I looked again one minute " before totality the black curtain had widened till it occupied " about 120° of the horizon. Burgos lit by a silvery light from " the sun stood out against the gloom behind it. Venus showed " at this time as a very bright spot, that required no searching for, " on a violet background. At totality the clouds round about " the eclipse were almost indigo at their centres and had lurid " golden edges. When two minutes of totality had passed I " looked again at Burgos. The town and citadel were now " a deep black, no detail being visible, but the forms of the " spires and citadel walls were silhouetted against a distant broad " horizontal streak of lurid orange light, a colour often seen " at dawn, and probably the effect of the coming sunlight seen " through the chilled moist air of the eclipse shadow, a complete " reversal of what I had seen before. The colour of the corona " was a vivid silver. The moon seemed to be darker than the " surrounding clear sky and slightly lurid.

" About a minute before totality, the sun being about to " emerge from a very large cloud, a beautiful iridescent patch " appeared on a detached rather tenuous cumulus cloud below " the sun. It did not appear to me to be part of a halo, being " too far off the sun for a coronal ring and too near for part " of a 22° halo. The patch was about 3° in width and the " colours, red, pink, blue, and orange, seemed in no order.

" As the moon's shadow was travelling one mile in 2·6 " seconds it follows that four minutes before totality I saw the " coming dark curtain when it was yet 92 miles away."

Mr. T. W. Backhouse, who observed the eclipse near Cistierna, writes :—" The colouring of landscape and sky was not so brilliant " and striking as in 1900, but it was very peculiar and inde- " scribable, though the time was too short to examine it carefully. " There was a lurid effect, and the blackness both of the heavens " and of the dark patches of the landscape was awful. There

" was, I think, a blue or purple tint in it; while in the far " distance the sky low down was very brilliant and of a lurid " straw colour, especially towards the end of totality; probably " this sky (whether sky or cloud it was impossible to say) was " beyond the limit of the shadow. This brightness might include " the distant plain, but as I could not see the horizon (which " from this altitude would be very distant), I cannot say. The " whole effect was *awfully grand*, and the dense showers of rain " here and there, though blotting out parts of the view, added " to the effect."

Mr. R. Leetham Jones observed that, half-an-hour before totality, a large patch of blue sky, low down in the south, became gradually paler in tint, the varying hues being exceedingly beautiful to watch. During the partial phase the sun's light appeared to change by degrees from golden to silver, the landscape assuming more and more of a silvery tint. Five minutes before totality a ray of sunlight upon the town of Burgos was almost as silvery as the light of the full moon.

At the same period the rift through which the sun shone became darker and darker in hue, and the planet Venus appeared as a snow-white spot on a violet background. Before disappearance the sun shone with an intensely vivid silver light, the corona showing for four seconds before totality. The western horizon was clouded, with a horizontal rift (about 15° altitude), through which the distant sky was visible. Before totality Mr. Jones noticed these western clouds become suddenly inky black, and the long rift changed in an instant from blue to dull yellow, the scene reminding him of some sham sky painted for a theatre. Then almost immediately the yellow burst out into a magnificent glow of rosy gold, the effect being one of dawn and sunrise. He could not trace the actual edge of the shadow. He observed the prismatic effect of iridescent light extending all round the sun some 5° from it two or three minutes before totality. The corona remained visible for about four seconds after totality.

Mr. H. Keatley Moore writes:—"My own observation of colour " was limited to closely before totality, when I saw dark violet, " almost black, clouds above and not quite so dark beneath, the " sky showing pale orange yellow, with a few reddish streaks in " between. Burgos Cathedral towers and the Castle hill were " quite visible against the lower dark clouds. The general effect " was of strong contrast, almost a black-and-white effect.

" From comparison with other observers, I believe that the " pale orange yellow I saw deepened in the red direction. Those " who observed the same effect later call the sky definitely " orange, and those later still call it red. It seems evident that " the colour deepened at and during totality."

Mr. W. N. McClean, A.M.Inst.C.E., describes the dark clouds on the western horizon with the horizontal streak, and gives the colouring as black and yellow a few seconds before totality. He observed coloured rings round sun and moon before and after totality, showing beautifully in patches on fleecy clouds.

Mr. A. E. Oakes writes:—" My impression of the colour of " the sky just before and during totality was that it was like " deep orange streaks on an indigo background."

Mr. Stewart Dick writes:—"At the moment of totality there "was a glowing ring of lambent light round the horizon, a band "of yellow, like the afterglow of a sunset. On the reappearance "of the sun the band of sunset light suddenly faded and gave "place to a paler glow."

Miscellaneous Notes.

The following times are those observed at Campo de Lilaila, Burgos:—

	h	m	s	
2nd contact - -	1	6	36½	
3rd „ - -	1	10	21	
Duration - -	0	3	44½	(by rated watch and by metronome).

This makes the time of totality about 8½ˢ sooner than the data given in the "Nautical Almanac" for a position S.W. of Burgos, though one would expect it to be 13¼ˢ later. Dr. Downing states that the computed times for the position S.W. of Burgos were in error as much as 12ˢ or so too late, owing to the moon's error in Right Ascension, therefore the discrepancy dwindles to 9¾ˢ.

The inner corona, which most of the observers describe as being of a pure white and intensely bright, was seen by Capt. Carpenter about 3ˢ before, and for about the same time after totality. The outer corona was of the usual maximum sun-spot type, and no very extended streamers were seen.

Neither the Zodiacal Light nor any intra-Mercurial planet, though carefully looked for during totality, could be detected. Venus was the only planet and Regulus the only star seen.

The body of the moon presented the appearance of a disc of a dull grey-black colour. Before totality Mr. C. L. Brook suspected a portion of its periphery beyond the sun's limb; after totality he felt certain he could see a small portion, equal to about 3 minutes of arc, outside both cusps. It was seen by Mr. and Mrs. Johnson immediately after first contact for perhaps half its circumference. The same two observers noticed that the wind entirely dropped during totality, springing up immediately afterwards from the same quarter as that from which it had previously blown.

Besides the effects on animals, &c. already mentioned, not many seem to have been noticed during totality, the chief being the braying of donkeys, the scampering about of a cavalry horse, and the going to roost of a canary.

Mr. A. E. Eaton, a naturalist, who joined Mr. Krauss Nield's party on the steamer, sends an interesting account of his observations of the behaviour of bees, wasps, and ants during the eclipse. He says that the bees remained in activity until about 15 minutes before totality, and that the ants all ceased work and went to sleep immediately it grew dark, waking up and resuming operations shortly after the light returned.

The Expedition to Labrador.

The first suggestion of the possibility of arranging an eclipse expedition from England to Labrador was made by Mr. T. R. Clougher at the Meeting of the Association held on February 22, 1905, at which he stated that the Dominion Government were arranging to send a party to Labrador for the eclipse, and he promised to communicate with the Royal Astronomical Society of Canada in order to ascertain if any facilities for joining this expedition could be extended to Members of the Association. In response to this enquiry Mr. Joseph Pope, Under-Secretary of State for Canada, on behalf of the Canadian Premier, invited Mr. and Mrs. Maunder to become the guests of the Canadian Government on the expedition, and offered to reserve three further places for Members of the Association, an offer eventually accepted by Mr. Charles Upton and Mr. Frank Jennings, the fifth place being filled by Mrs. Maunder's brother, Mr. J. A. Russell. The fullest acknowledgments are due from the Association to the Dominion Government for this generous courtesy, by which they did all that lay in their power to afford the opportunity to British astronomers for solving the problem that is, perhaps, the most important one now presented to eclipse observers, the question as to whether the corona shows distinct change in an interval of two hours or so. Especial sympathy is due to the Canadian astronomers in that unpropitious weather conditions prevented the obtaining of any results either by their own splendidly equipped party or by their English guests, and so frustrated their own hopes and the benefits which they had intended to confer by their most considerate and hospitable offer.

The Members of the Canadian expedition were taken to their station in two parties. The first party sailed in the "King Edward" from Quebec on August 4, reaching North West River, the place of their encampment, on August 11. The "King Edward," after landing its passengers and their instruments and camp equipment, returned to Quebec, and brought the second contingent, which reached North West River on Monday August 28, two days before the eclipse. The first party lived in tents, pitched close to their instruments, during the three weeks of preparation, the camp being set up on the strip of sandy foreshore that lies between the forest of spruce firs and the North West River just where it empties itself into Lake Melville. The situation entailed a considerable amount of very hard work, as, owing to the shallowness of both lake and river, the camp requisites and the instruments, amounting to many tons in weight, had to be lightered from the ship to a miniature wharf distant some two miles from where the ship was anchored, and from the wharf had to be conveyed over very rough ground half a mile or more to the only spot available for the camp, in a couple of wheelbarrows and a handcart, by haulage of the members of the expedition. There was hardly any assistance to be obtained at the station, as the resident population of the place consisted only of the Hudson Bay factor, who was seriously ill at the time, and

the two factors in charge of a French fur trading station on the opposite bank of the river, some two or three half-breed trappers, and a small company of Montagnais Indians, temporarily encamped at the station and suffering from an epidemic of measles. The residents were willing to aid in every way that was in their power; Mr. Cotter, the Hudson Bay Company's factor, being especially anxious to assist, but his illness prevented his doing as much as he desired to do.

The day of the eclipse was completely cloudy, and hence no results were obtained, and there is no need to go into the full details of the instruments and programmes of the various members of the expedition. The new Dominion Observatory at Ottawa had the largest and fullest equipment, and its Director, Dr. W. F. King, was the official head of the whole expedition. The outfit was devised and superintended by Mr. J. S. Plaskett, and its principal items were four great telescopes of focal length 45 feet, 10 feet, 10 feet, and 7 feet respectively, together with three spectrographs, all fed by a 20-in. cœlostat. Mr. Plaskett proposed to ascertain the distribution of colour in the corona by using variously coloured screens. Mr. Menzies from the Magnetic Observatory of Agincourt, near Toronto, had a very ample magnetic installation; and Mr. Stewart determined the geographical co-ordinates of the camp and the force of gravity. These two gentlemen were the only members who could claim to be successful, as their work was independent of the weather during the eclipse. Dr. Marsh and Mr. Jenkins, of the Hamilton Astronomical Society, had three photographic telescopes and a grating camera with which they proposed to obtain photographs of the corona and of its spectrum. Father Kavanagh, S.J., intended to observe the outer streamers with the naked eye, employing a special device to exclude the light of the inner corona. Mr. Collins, of Toronto, the Secretary of the Royal Astronomical Society of Canada, had a telescope of his own design and construction, a combination of a reflector and a refractor. Mr. Maunder had two instruments, a 4-in. photoheliograph and a Rapid Rectilinear lens, both belonging to Greenwich Observatory, and intended to obtain photographs of the corona, for comparison with those secured in Mauritius in 1901, and with those the Astronomer Royal was taking at Sfax in Tunis on the present occasion. Mrs. Maunder had with her the Dallmeyer stigmatic lens used in India in 1898, a Goerz lens, the duplicate of one in use by Prof. Turner in Egypt, and a 3½-in. Cooke lens with which it was hoped to secure a series comparable to the negatives taken with the Newbegin telescope in 1901. Mr. Jennings assisted Mr. Maunder; Mr. Upton and Mr. Russell assisted Mrs. Maunder.

The locality where the eclipse expedition was encamped at the head of Lake Melville has been described as the "garden of Labrador," and rightly so, for here and here alone in Labrador is a garden to be found. Its natural fitness for such cultivation is the possession of a very little sandy soil on which skunk berries and wild raspberries make shift to grow, and this is much in Labrador where all the coast is bare scoured rock. Nevertheless

it has claims to interest as being the place of the earliest settlement by Europeans on the American continent. This was in the days long before the "discovery" of America by either Columbus or Cabot, when Bjorni, the companion of the Viking Eric the Red, in trying to make Greenland, A.D. 1001, missed Cape Farewell and made the coast of Labrador. A little later a small colony was planted here, which persisted for some considerable number of years. Probably the place has altered less since those days than any other on the whole globe.

The Partial Phase.

By Col. E. E. Markwick, C.B., F.R.A.S.

(At Boscombe, Hants.)

Although a "stay-at-home," perhaps I may be permitted to note something which struck me when observing the recent eclipse of the sun on August 30, namely, the remarkable distinctness of some mountains which broke up or diversified the lunar limb. I was fortunately favoured with first-rate definition; at times there was a layer of very thin cirrus cloud, which steadied the atmospheric undulations wonderfully well, and the image seen with a solar diagonal, power 67, on a $2\frac{3}{4}$-in. refractor, was frequently as steady as could be wished.

At 12^m past noon four large mountains were quite easily seen, projected against the sun's disc. They had, as a rule, gradually sloping sides, and looked in shape not unlike waves with pointed crests. They are lettered E, F, A, and B in the accompanying Fig. 1, in which they are necessarily exaggerated

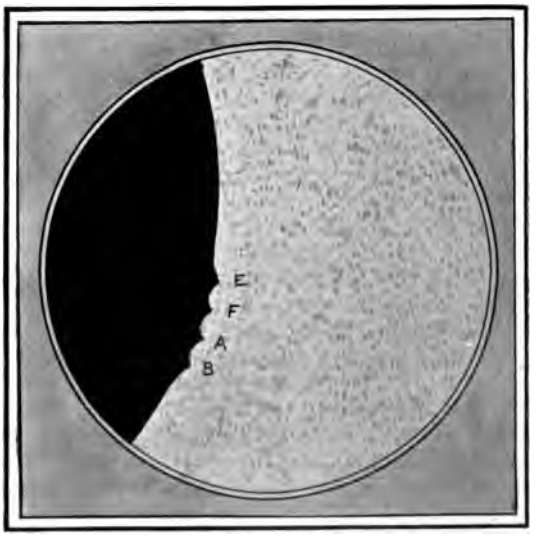


Fig. 1.—General view of four mountains on moon's limb.
$12^h\ 12^m$ G.M.T.

in height, as, although distinct in the telescope, if drawn to scale on paper, they would hardly be seen.

On further scrutiny, during moments of fine definition, three small and apparently rounded hills were distinctly seen in the hollow between the peaks A and B. They looked like tiny black

nipples on the limb, and are shown in a more or less exaggerated way and on a larger scale in Fig. 2.

Fig. 2.—Enlarged view of mountains A and B, with three small hills between. $12^h\ 15^m$ G.M.T.

Fig. 3.—Two other mountains, one of which is exactly dichotomised by the sun's limb. $1^h\ 47^m$.

Unfortunately, I did not take the position angles of this group of four mountains; and in a diagonal the vertex may be anywhere, according as one twists round the diagonal and observes from right or left side of the telescope, or midway with the eye-piece in the same vertical plane as the axis of the telescope. However, on estimating what the position-angle probably was, I find that these mountains correspond well enough with the position of the Rook Mountains, numbered 276 in the lunar map accompanying "Celestial Objects." Four elevations are there shown exactly on the limb, the position angle of the middle of them being about 111°. Webb, referring to this locality, says, "The Cordilleras (274) and D'Alembert Mountains "(275), a series of great ranges, nearly 20,000 ft. in general "height—much higher, according to Schröter, in parts—rise "along the E. limb. They extend far S., and this extremity is "called the Rook Mountains (276). Two valleys were dis-"covered by Schröter in profile on this limb, of enormous depth, "rivalling the height of the mountains."

Although uncertain, then, on the whole I am inclined to think that the Rook Mountains are those that were seen; but I am open to correction, as I am unable to say whether or not the libration at the time was such as to exactly allow these particular mountains to be in profile on the lunar limb.

Later on, two other elevations came into view in quite a different part of the limb, and at $1^h\ 47^m$ the sun's limb exactly touched the summit of one of them. This is indicated, as well as may be, in Fig. 3. These I am unable to identify with any degree of certainty. It is noteworthy that the accurate Webb refers to ranges which "sometimes roughen the limb during a "solar eclipse, but Schröter found that their peaks then appear "much sharper from the irradiation of the sun."

I fear that the preceding remarks can hardly be regarded as other than astronomical *nugæ;* yet, even so, they may be of interest in showing what may be seen in a small telescope. From accounts which have been already published it seems that several observers have noticed the serrated edge of the moon on this

occasion, although all are not in agreement on the point. Airy, at the eclipse of 1851, July 28, says he saw the mountains of the moon perfectly well; also he saw "the moon's serrated limb "advance up to the sun's, and the light of the sun glimmering "through the hollows between the mountain peaks."

I looked very carefully for the moon's limb outside the solar disc, but failed to see the slightest sign of it. I *did* see a mysterious ghost of one of the cusps of the solar disc, and made a drawing of it. It looked something like a faint comet with curved and diverging tail. I can easily understand how, with this really telescopic ghost or reflection in approximately the right position, one could imagine he saw the moon's limb projected on the corona. At the same time it would appear that some in Great Britain did really see the moon's limb so projected.

ADDENDUM.—The old proverb, "there is nothing new under "the sun," is constantly being verified. Since the above paper was written I find that Members of our own Association have on previous occasions observed and figured the rough edge of the moon when projected against the solar disc. *See* "Journal," Vol. V., p. 312, and Vol. VII., p. 148, where there will be found drawings of irregularities on the moon's limb observed at the solar eclipse of 1895, March 26, by Messrs. S. H. R. Salmon and W. H. Skelton respectively.

By Mr. W. A. PARR.

(At Florence.)

The partial phase of the total solar eclipse of August 30 was observed by me here under very favourable conditions. Rain fell during the preceding day and the early morning hours of the 30th, so that the atmosphere was wonderfully transparent, rendering all telescopic details singularly clear and well defined. Only shortly before the end of the eclipse did clouds render observation difficult.

My instrumental equipment consisted of a 3-inch refractor by Steward, fitted with a first-surface prism solar eye-piece and dark wedge with a power of 80 for direct vision; and a $2\frac{1}{8}$-inch Ross refractor with power 80 for the projected image.

There were four groups of spots visible on the sun's disc, which I have designated *c*, *d*, *e*, *f*, respectively, and the following transits of the moon's limb were noted:—

			h	m	s	
Group	*c*	ingress	1	52	30	Cent. Europ. M. T.
,,	*d*	,,	2	18	0	,,
,,	*f*	,,	2	29	0	,,
,,	*c*	egress	2	51	0	,,
,,	*d*	,,	3	21	30	,,

c was the most westerly group, and *d* was approaching the central meridian; *e*, a large spot, surrounded by bright faculæ and showing much detail, was first noticed on the eastern limb on the 28th August, while *f* was first seen by me on the morning of the eclipse on the extreme eastern edge of the disc.

The changed position of the vertex and general shift of the spots, as a whole, was very noticeable as the eclipse wore on.

The first contact took place at 1.13 p.m.
„ last „ „ „ „ 3.40 p.m. } Cent. Europ. M. T.
„ max. phase „ „ „ 2.29 p.m.

and the magnitude of the eclipse (calculated for Florence) amounted to 0.83, as shown in a diagram prepared by Dr. B. Viaro, of the Arcetri Observatory, Florence, and kindly placed at my disposal by Prof. Abetti, the Director.

As the body of the moon, which appeared densely black compared with the nuclei of the spots, advanced across the sun's disc, its limb showed very well-marked undulations and irregularities, which owing to the "hard" and steady image, could not be ascribed to any effect of "boiling." The S.W. portion of the lunar limb, in particular, showed a permanent elevation like a raised plateau seen in profile, the position corresponding with that of the Mare Australe.

The moon's limb, however, could not be followed outside the sun's disc, but appeared to end abruptly at the edge of the latter; while the solar cusps appeared sharp throughout.

Shortly before the time of maximum phase, Venus appeared plainly visible to the naked eye, showing a gibbous form in the telescope. But one of the most beautiful optical effects about this time was the formation of hundreds of crescent-shaped images of the sun on the ground beneath trees and beneath the matting which covered a portion of the terrace from which I was observing. These little images of the sun, which produced a curious flickering effect, faithfully followed the phases of the eclipse, but were most beautiful when reduced to the narrow crescents which corresponded to the maximum phase, during which only 0.17 of the sun's disc remained uncovered.

Another interesting effect of this phase was produced by the densely black and sharp shadows, similar to those produced by the electric light; while the marked change of tint on the surrounding landscape due to the diminution of the sun's light was weirdly beautiful. Surrounding objects lost their natural colours, and the whole landscape had the appearance of being viewed through a very light sun-cap, the greens, especially, appearing quite black.

A marked change was also noticeable in the temperature, for the thermometer, which indicated 85° F. in the sun before the eclipse, sank to 69° about the time of maximum phase. The eclipse, even in its partial phase, was a most interesting one.

INDEX.

Absorption Bands, 26.
Adames, H. B., 36, 43.
Alcala de Chisvert, 26.
Animals, &c., Effects on, 26, 55.
Astronomer Royal, The, 25.
Aurora Borealis, 37.

Backhouse, T. W., 28, 42, 53.
Baden-Powell, Major, 16.
Baily's Beads, 8, 16, 23, 32, 40, 45.
Benson, D. E., 14, 15.
Berry, Miss, 5.
Boscombe, 59.
British Astronomical Association, 1, 2, 12, 25.
Brook, A. C., 52.
„ C. L., 55.
„ Mrs. A., 34, 51.
Bruford, G., 5, 49.
Burgos Cathedral, 7, 9, 54.
„ Position of, 1.
Burns, G. J., 17.

Cafferata, L., 20, 22.
Campo de Lilaila, 4, 6.
Canada, Royal Astronomical Society of, 56.
Carpenter, Capt., 48, 49, 53.
Cás Catalá, 19, 52.
Cayley, Mr., 50.
Chambers, G. F., 1, 23, 31.
Chromosphere, The, 10, 13, 24.
Churchill, Mr., 50.
Cirera, Señor R., 25.
Cistierna, 28, 42, 53.
Claridge, Rev. J. T. W., 50.
Clougher, T. R., 56.
Colours and Atmospheric Effects, 5, 6, 7, 8, 9, 10, 28, 37, 39, 52, 62.
Columbretes, The, 34.
Corona, The, Brightness and Colour of, 5, 9, 13, 17, 24, 26, 27, 28, 33, 34, 35, 55.
„ „ Shape, Size, &c. of, 10, 11, 13, 15, 17, 19, 20, 22, 24, 28, 29, 34, 46, 48.
„ „ Visible before and after Totality, 8, 33, 55.
Cortie, Rev. A. J., 20, 22.
Crescent images of the Sun, 62.
Crommelin, A. C. D., 16, 42, 50.
Cubitt, Capt., 32, 34.

Darkness during the Eclipse, Degree of, 8, 11, 13, 15, 17, 18, 24, 28, 29 32, 34, 38, 39.
Dick, S., 55.
Dickson, E., 40, 41.
Dolmage, Dr., 38.
Dörfel Mountains, 32.

Eaton, A. E., 55.
Eclipse seen at Sunrise, 36, 37.
„ Wind, 28, 33, 55.
Elche, 27.
Everett, Miss A., 17.

Flash Spectrum, The, 13, 15, 26, 41 44.
Florence, 61.

Gear, J. H., 2, 3, 50.
Gibbs, W. B., 13.

Halley, E., 23.
Hart-Davis, Miss K. L., 18.
Hodge, R., 18.
Horns, Blunting of the Sun's, 18, 23.
Howarth, E., 9.

Iniguez, Señor, 5, 16.
Intra-Mercurial Planet looked for, 55.

Jennings, F., 56.
Johnson, Mr. and Mrs., 55.
Joly, Prof., 21.
Jones, L., 49, 54.

Killip, Rev. R., 2, 14.
King, Dr. W. F., 57.

Labrador, The Discovery of, 58.
„ The Expedition to, 56.
Lake Melville, 56, 57.

Laurier, Sir W., 1.
Lea, R. N., 36.
Leahy, Prof., 17, 18, 50.
Léon, 28.
Liddell, A., 20, 22.
Liverpool Astronomical Society, 2.
Longbottom, F. W., 2, 33.

McClean, W. N., 49, 54.
M'Keon, W., 22.
Manitou, 36.
Markwick, Col., 59.
Maunder, E. W., 1, 13, 16, 56, 57.
„ Mrs., 1, 56, 57.
Maw, W. H., 2.
Mercury looked for. 8, 13, 34.
Meteorological Observations, 42, 43.
Moon, Flat appearance of the, 55.
„ Irregularity of the Limb of the, 18, 19, 59, 60, 61, 62.
„ Shadow of the, 10, 11, 13, 32, 38, 39.
„ Spherical appearance of the, 38.
„ Visibility of the, against the sky. 18, 55.
Moore, H. K., 48, 49, 54.
Morford, Rev. A., 20, 22.
Moye, Prof., 26.

Navalmoral, 9.
Niblett telescope, The, 13.
Nield, H. K., 11.

Oakes, A. E., 54.
Over-concentration, A Warning against, 18.

Page, Miss E. I., 16.
Palma, 16, 17, 18, 42.
Parr, W. A., 61.
Partial Phase, The, 59, 61.
Peña Corada, 28.
Phillips, Rev. T. E. R., 2, 6, 40, 43, 44, 49, 50.
Photographic Results, 44.
Plaskett, J. S., 57.
Polytechnic Touring Club, The, 1.
Pope, J., 56.
Proctor, Miss M., 48.
Prominences, 10, 13, 16, 17, 20, 22, 23, 24, 26, 27, 29, 31, 32, 33, 35, 36, 37, 47, 48.

Regulus seen, 13, 55.
Reversing Layer, The, 7.
Rifts in the Corona, 27, 35, 46.
Roca, Dr. S., 22.
Rook Mountains, 60.
Roquetas, 25.
Royal Irish Academy, The, 21.
Russell, J. A., 56.
Ryves, P.M., 30.

Sanger-Shepherd screen, 14.
Saunder, S. A., 32, 33.
Shadow-bands. 15, 24, 27, 33, 34, 49.
Sharp, I., 28, 29.
Skinner, Mr., 49.
Soria, 30.
Spain, H.M. the King of, 4, 5.
Spectroscopic Observations, 40, 41.
Stevens, Miss C. O., 19, 52.
Streamers. 9, 10, 16, 19, 20, 22, 27, 28 29, 33, 35, 46, 48.
Sunlight, the Return of, 8, 11, 24, 26, 55.
Sun-spots, 6, 20, 23, 61, 62.

Tabor, C. J., 25.
Tarragona, 25.
Temperature Charts, 43, 44.
„ Fall in, 5, 62.
Thorp, T., 40.
Thorp Gratings, 7, 13, 15, 40, 41, 45.
Thwaites, C., 1, 2, 3, 4, 9.
Times of Contacts, 6, 8, 16, 23, 25, 26 29, 30, 55, 62.
Todd, Prof., 16.
Tortosa, 23, 25.
Totality, Duration of, 5, 8, 16, 24, 29, 54.

Upton, F., 56.

Venus seen, 7, 9, 26, 28, 34, 37, 52, 53 55, 62.
Vinaroz, 20, 22, 23.

White, J. H., 33.
Whytewold, 37, 43.
Willis, J. H., 43, 51.
Woolston, Miss, 48.

Zodiacal Light looked for, 55.

THE NEW YORK PUBLIC LIBRARY
REFERENCE DEPARTMENT

This book is under no circumstances to be taken from the Building

Form 419